TIGHT BINDING BOOK

INTRODUCTION

All that follows has been written with one idea, namely, to place in simple non-technical language before the general reader a series of intimate sketches of some of the wonderful phases of Animal, Insect and Plant Life that form a part of the animate world around us. If these "close-ups" from Nature should stimulate the reader with a desire to go forth into the open country, or along the seashore, and there to strive to observe at first hand some of the incidents recorded, then the Author's labour will not have been in vain.

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CLOSE-UPS FROM NATURE

BIRD CRAFTSMANSHIP

HAVE you ever thought of the birds that visit your garden, or attract your notice during your country rambles by their gay plumage and sweet song, as skilled craftsmen? Probably you have not done so, for I find that the majority of folk, even those who have lived most of their lives in the country and have therefore had ample opportunity for observation, have never considered birds from this aspect—it is always the plumage and song that has appealed to them. Yet, for a few weeks in the spring or early summer, many birds become skilled craftsmen, constructing the most beautiful and perfectly designed homes, in which to rear their offspring. And that is another point which we are all too apt to overlook, namely, that the nest of the bird is a home, and therefore something that we should consider as precious beyond price, not on any account to be destroyed or violated.

I can never look at the delicate, shallow saucer of slender twigs, lined with a padding of fine fibrous roots and horsehair, which forms the nest of the Bullfinch, without thinking of Ruskin and the impression a particularly beautiful nest made upon

him, perhaps the first time that he had thought of the bird as a craftsman: "The other day I was calling on the Ornithologist whose collection of birds is, I suppose, altogether unrivalled in Europe (at once a monument of unwearied love of science, and an example, in its treatment, of the most delicate and patient art)—Mr. Gould. He showed me the nest of a common English bird; a nest which, notwithstanding his knowledge of the dexterous building of birds in all the world, was not without interest even to him, and was altogether amazing and delightful to me. It was a bullfinch's nest, which had been set in the fork of a sapling tree, where it needed an extended foundation. And the bird had built this first storey of her nest with withered stalks of clematis blossom; and with nothing else. These twigs it had interwoven lightly, leaving the branched heads all at the outside, producing an intricate Gothic boss of extreme grace and quaintness, apparently arranged both with triumphant pleasure in the art of basket-making and with definite purpose of obtaining ornamental form. . . . The bird has exactly the degree of emotion, the extent of science, and the command of art which are necessary for its happiness; it had felt the clematis twigs to be lighter and tougher than any others within its reach, and probably found the forked branches of them convenient for reticulation. It had naturally placed these outside, because it wanted a smooth surface for the bottom of its nest; and the beauty of the result was much more dependent on the blossoms than the bird.

Thrush is a Master-Craftsman in the Art of Basketwork and Plaster

The Mossy Bowl of the Chaffinch Nest

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An Example of the Lesser Redpole's Craftsmanship

One of the Wonders of Bird Craftsmanship
The Nest of the Longtailed Tit

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few yards further on. This performance will be repeated again and again, until, judging that she has drawn you far enough away to make discovery of her precious home and its contents impossible, she flits off to some neighbouring bush or thorn tree, where she will wait and watch for your departure, that she may return and brood her eggs in peace and safety.

About the end of March the Chaffinch generally begins building operations, and although not very particular as to the nesting site—a hedge or bramble tangle, the tall laurels of a quiet garden, or the shelter of an ivy-mantled wall are all considered suitable situations—the bird does love the branches of an old mossy apple tree. However, once the site has been selected, an enormous amount of skill and loving care is bestowed upon the building of the nest, which, when finished, is a most perfect piece of craftsmanship. Flitting here and there, seeking diligently, the little Chaffinch collects green mosses, soft wool, cobwebs, hair, feathers and down; the whole being woven into a close, compact and shapely cup of wonderfully uniform texture and beauty. Nor is this all, for, once the structure is completed, the little Chaffinch will, should the material be available in sufficient quantity for its needs, proceed to bedeck the whole of the outside of its nest with various coloured lichens. A nest thus completed is a most beautiful and decorative piece of work, that can but fill us with admiration for its perfection of construction, and wonder at the skill and artistry of the little feathered craftsman.

An even more wonderful piece of craftsmanship is the work of the Long-tailed Titmouse, which, next to the Goldcrest, is the smallest of our British birds. Despite its small size, the Long-tailed Titmouse is a hardy, active, restless wee thing, very sociable and fearless, like its larger relations, the Blue and the Great Tits. It constructs a large, oval, lichen-covered nest, as big as a coconut, generally among thick thorns or brambles, or in the midst of a furze bush, though the bird is not over particular and will sometimes select a holly bush, a dense growth of ivy, or the fork in the branches of a willow, ash, or any other convenient tree as a nesting site. The work of construction generally starts with the weaving of the bottom of the nest, the material employed being chiefly moss and wool, held together by spiders' webs. Gradually the sides of the nest are built up, the wee birds at first working perfectly evenly upon the raising of the mossy walls; but as the work progresses one side of the nest begins to rise more rapidly than the other, and is continued over the top to form the dome of the nest, beneath which is the tiny entrance hole; while the whole of the interior is lined with feathers. Next, the exterior is encrusted all over with grey tree-lichens, and the formidable task completed. The amount of material used in the construction of the nest, and the labour of collecting and weaving it all together is truly marvellous. The lining, composed of feathers, alone must cost the birds an immense amount of toil, for no less than 2,379 feathers, once forming part of the plumage of the

Pheasant, Rook, Partridge, Wood Pigeon, Duck, and other birds, have been recorded by a well-known Naturalist as forming the lining of a Long-tailed Tit's nest.

The Lesser Redpole also eagerly seeks for feathers wherewith to line its nest, often using them with charming effect. The bird builds a small, compact and very beautiful nest, the framework generally being composed of slender twigs, grass stems and moss, woven neatly together, while the little cup is smoothly lined with cotton-grass, down, and feathers. I once saw a particularly beautiful example of the Lesser Redpole's craftsmanship, in which the bird had used the stems of the wild clematis, obtained from a hedge near at hand, for the outer wall; and had lined the cup with swan's-down, collected from the border of a neighbouring mill-pool, frequented by a pair of Swans. Not only had the little bird lined the nest with the swan's-down, but had used the material in such a manner as to form a most beautiful fringe around the edge of the cup, only the tips of the delicate white feathers showing, and curving gracefully inwards, so that they actually served as a partial screen to hide the eggs from view.

The smallest of our British birds, the Goldcrest, or Golden-crested Wren, to give it its full title, is a wee craftsman of particular interest, for it builds a pensile or true hanging nest. This tiny bird selects for building materials the softest moss and wool that it can find, and weaves these together with the aid of spiders' webs and slender grasses; the whole dainty

structure being suspended like a fairy hammock from the under side of the slender twigs at the end of the branch of a Larch, Fir, Yew, or other coniferous tree. When completed, this frail little nest is lined with a few small downy feathers.

A truly wonderful piece of basket-weaving is the nest of the Reed Warbler, which is generally built in the middle of a reed-bed, above the surface of some quiet pool. It is composed of long grass, the seed-heads of reeds, and a little cottony wool and moss. The grass stems that usually form the foundation are wound horizontally round about the stems of three or four tall reeds that, thus, actually pass right through and form part of the sides of the nest, which, as the process of weaving proceeds, assumes a somewhat conical shape, and is about five or six inches in depth when finished. This accomplished, the bird proceeds to work into the interstices of the walls the cottony material that it has collected from the catkins of the Willows and Poplars, and lines the cavity within, which is about three inches in depth, with the finest grasses and some hair. So securely, yet at the same time elastically, is this nest woven round the supporting reeds, and so ample its depth, that, no matter how the winds may swing and bend the reeds, there is no fear of the eggs rolling out, and the mother bird rests, safely and contentedly brooding them, within this most wonderful swaying cradle.

Both the Swallow and the House Martin are extraordinarily expert masons, and it is a cause of great regret and concern to all bird lovers that these

graceful and useful creatures appear every year to reach our shoes in smaller numbers. Therefore, every effort should be made to protect their nests and young from wanton destruction. A Swallow's nest is really a wonderful thing. It is made in the form of a semi-circular saucer or bowl, composed of mud pellets kneaded together with short fragments of straw, and attached to the beam or rafter of some farm outbuilding. When completed it is lined with straw, horsehair and fine grass, and feathers.

The House Martin builds its globular nest beneath the eaves or window ledges of our houses, using pellets of mud for the walls, and lining the nest with bits of straw and an inner cushion of feathers for the pure white eggs to rest upon. Neither the House Martin nor the Swallow has a particularly large mouth, so that the labour of constructing the nest must be very great, many hundreds of journeys having to be made backwards and forwards in order to carry sufficient mud for building up the walls of the nest.

I have purposely only mentioned the nests of familiar birds, but I hope these examples may have served to show the bird as a craftsman.

THE OWL

" Alone and warming his five wits,
The White Owl in the belfry sits."
—Tennyson.

Because of its nocturnal habits and strange uncanny voice, the Owl has been regarded throughout the ages as a very doubtful character; as a bird of ill-omen, a harbinger of death and disaster. Indeed, when we dip into ancient history we find that of the old civilisations, Greece alone held the Owl in high esteem. To the Athenians the bird was of special importance, and an Owl is depicted on the reverse side of many of their coins, for it was sacred to their guardian deity, Athena. By them it was regarded as an emblem of learning, sacred to Minerva, the Goddess of Wisdom, who in some of the ancient sculpturings is shown as the Owl-headed goddess. The bird that is depicted on these ancient coins appears to be the Little Owl (*Carine noctua*), which has always been common in Greece, and during the last fifty years has become thoroughly established as a resident in Great Britain and Ireland.

The Romans, on the other hand, cordially disliked and dreaded the Owl, looking upon it as a profane and unclean creature, whose presence portended ill to both the individual and the State.

Virgil introduces the bird into his description of the prodigies and horrors that presaged the suicide of Dido, and in Book XII of the Æneid, one of the Diræ sent down by Jupiter to conclude the scene between Æneas and Turnus, appears in the form of an Owl. That Pliny had no good opinion of it we gather from the following translation of his remarks on the Eagle Owl (*Bubo ignavus*): "The Bubo (*Owl*) is a fatal bird, of evil omen beyond other sorts, especially at public auguries; it lives in desert places, and not merely those that are unpeopled, but those also hard of access. Monster of the night, it utters not a song, but only a groan. It never flies where it intends, but is borne off aslant"—the last remark referring to the undulating flight of this bird. We also learn that upon two occasions Rome had to undergo lustration in consequence of an Owl alighting on, and, during its second visit actually daring to enter, the sacred portals of the Capitol. One of these birds was caught, burnt in public, and its ashes thrown into the Tiber as an act of purification.

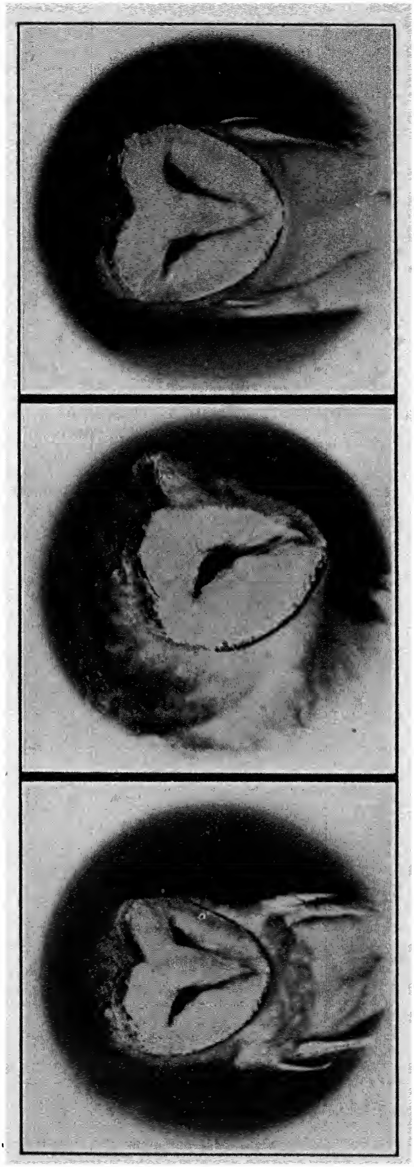
In ancient medico-astrological works frequent reference is made to various parts of the Owl as constituting the most important ingredients for the successful compounding of certain charms and nostrums. Thus, the ashes obtained by burning the feet of the owl, together with the herb plumbago, formed a charm against serpents; while, should the heart of the bird be placed on the left breast of a sleeping maiden, it would cause her, during sleep, to reveal to the bedside watcher all her secret

thoughts and dreams. The warrior who carried the heart of an owl as a charm when going into battle, was assured of added strength and success against his foes. What must surely rank as one of the strangest cures for baldness was an ointment compounded of Owl's eggs and the unhappy nestlings of the bird. The ashes of Owl's eyes were credited with promoting clearness of vision; while an ointment made up from the ashes of the bird's head was said to be a valuable specific against disorders of the spleen!

In Elizabethan days there was a very general belief in the ill repute of the Owl, and we find Shakespeare making frequent reference to the bird of darkness in his plays. The Owlet's wing formed part of the ingredients of the witches' cauldron in *Macbeth*, and during the murder scene Lady Macbeth exclaims: "Hark! Peace! It was the Owl that shriek'd, the fatal bellman which gives the stern'st good night." And when the murderer rushes in, crying: "I have done the deed. Did'st thou not hear a noise?" she replies: "I heard the Owl scream;" and again later: "The obscure bird clamour'd the live-long night."

Of the ill-omen of the bird appearing during the hours of daylight we find the following references in *Henry VI*, *Richard III*, and *Julius Cæsar*:

"The Owl by day, if he arise, is mocked and wondered at."—"For night owls shriek where mounting larks should sing."—"Yesterday the bird of night did sit, even at noonday, upon the market-place, hooting and shrieking."



STUDIES OF THE FACIAL EXPRESSIONS OF THE BARN OWL

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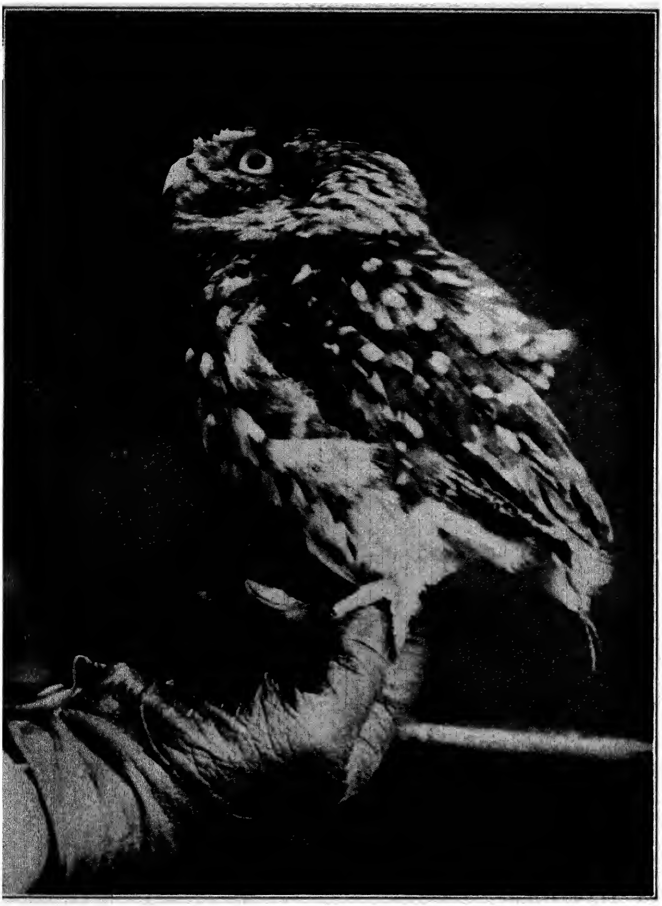

The Little Owl Makes a Charming and Interesting Pet

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In Henry VI's speech to Gloster—"The Owl shriek'd at thy birth, an evil sign"—we catch sight of the then popular belief that an owl, appearing or being heard at the time of a birth, forbode misfortune; while in *A Midsummer Night's Dream* its association with impending death is shown: "The Screech-Owl, screeching loud, puts the wretch that lies in woe, in remembrance of a shroud."

But one of the most curious superstitions relating to the Owl, Shakespeare puts into the mouth of the distraught Ophelia: "They say the Owl was a baker's daughter." Staunton, in his edition of the Plays, states that this remark by Ophelia has reference to the following tradition, once generally current in England (it was a familiar story among the country folk of Gloucestershire as late as 1807): "Our Saviour went into a baker's shop where they were baking, and asked for some bread to eat. The mistress of the shop immediately put a piece of dough into the oven to bake for Him, but was reprimanded by her daughter, who, insisting that the piece of dough was too large, reduced it considerably in size. The dough, however, immediately afterwards began to swell, and presently became of an enormous size. Whereupon the baker's daughter cried out: 'Wheugh! wheugh! wheugh!' which owl-like noise, it is said, probably induced our Saviour, for her wickedness, to transform her into that bird."

We find the idea of the transformation of a person into an Owl in the old North-country nursery song:

"Oh! hoo, hoo, hoo!
I once was a King's daughter, and sat on my father's knee,
But now I'm a poor Owlet and hide in a hollow tree."

The late Charles Waterton gives another version of this ancient nursery rhyme, and states that it was sung to the old tune of the storm, "Cease, rude Boreas, blust'ring railer":

"Once I was a Monarch's daughter,
And sat on a lady's knee;
But am now a nightly rover,
Banished to the ivy tree,
Crying, hoo, hoo, hoo, hoo, hoo, hoo,
Hoo, hoo, hoo, my feet are cold!
Pity me, for here you see me,
Persecuted, poor, and old."

The Owl to which Shakespeare and these old legends refer, is obviously the commonest of our British species, the Barn Owl (*Strix flammea*), perhaps more widely known under its two popular country names of White, or Screech Owl. I am glad to say that at long last this beautiful and innocent bird is slowly but surely coming into his rights and ceasing to be so universally persecuted by the farmers and gamekeepers, who for generations have waged such a senseless war upon him. As a matter of fact, the Barn Owl should be an object for special interest, care and protection, by all who are in any way connected with agriculture, on account of the enormous numbers of rats, mice, and other vermin which the bird destroys; indeed, the Barn Owl is directly beneficial to the farmer to the extent

of no less than 85 per cent of its food. An analysis of the stomach contents made by that eminent authority, Dr. Walter E. Collinge, of York, shows that of the total bulk of food consumed by the Barn Owl, 68.5 per cent is composed of mice, rats, and voles; 9.5 per cent of small birds, of which the injurious house sparrow bulks largely; 7.5 per cent of injurious insects, and 1 per cent of neutral insects. Another careful observer, in an examination of 1,124 pellets or castings of the Barn Owl, found them to contain the remains of 2,397 mice and rats, and ninety-seven sparrows; while the late Lord Lilford, in his *Birds of the British Islands*, states that he had "examined hundreds of the pellets cast up by this species in and under their nesting places, and never discovered either the bones or feathers of any game-birds, the castings consisting mainly of the fur and bones of small mammals, with feathers and skulls of seed-eating birds, and occasionally a few bones and scales of small fish." In continuing his account of this interesting bird, Lord Lilford says: "A young Owl of this species that I kept as a pet in my schooldays, on one occasion, when half-grown, swallowed nine full-grown house-mice in rapid succession, till the tail of the ninth stuck out of his mouth, and he could do no more; but within three hours he was hungry again, and was barely satisfied with four more of the little quadrupeds. With this appetite and capacity for stowage, the numbers of four-footed vermin supplied by a pair of Barn Owls to a brood of six or seven ravening youngsters may be well imagined. I have

seen an old pair bring food to their brood seventeen times in half-an-hour, from a rick-yard near their nest."

The Barn Owl frequents old ruins, barns, church towers, and similar situations, where it sleeps away the hours of daylight, only flying abroad at dusk in search of its food, and once again returning to its secluded retreat with the first grey glimmer of the dawn. Its call is loud and harsh, and particularly during the breeding season the birds give vent to the most uncanny sounding shrieks. The cry is most frequently uttered early in the evening, when the bird commences its nocturnal coursing, and again before dawn.

It appears to be a fairly well established fact that a kind of friendship or tolerance exists between Barn Owls and domestic pigeons, for many instances are on record of Barn Owls having taken up their residence in pigeon-lofts, and of living there on perfectly friendly terms; indeed, doing the rightful inhabitants a good turn by preying upon the rats that are so often responsible for serious depredations among the pigeon nestlings in the loft.

Bishop Stanley relates the following case where the Owls were performing this friendly service: "A person who kept pigeons and often had a great number of young ones destroyed, laid it on a pair of Owls, which visited the premises; and accordingly one moonlight night he stationed himself, gun in hand, close to the dove-house, for the purpose of shooting the Owls. He had not taken his station long before he saw one of them flying out with a

prize in its claws; he pulled the trigger, and down came the poor bird, but instead of finding the carcase of a young pigeon, he found an old rat, nearly dead."

The breeding habits of the Barn Owl have many points of interest. No nest is constructed, though occasionally a few twigs and grasses or straw may be collected to form a rough bed; but generally the eggs are laid on the bare floor of the darkest corner of the old church tower or other nestling site. Early in April, sometimes even in March, should the weather be mild and open, mother Owl begins to lay her eggs; and as soon as she has a couple she begins to sit on them, although her full complement of eggs is rarely less than six, and may number nine; the remainder being laid at intervals of about a week. Consequently, as the season advances, all stages are to be found in the nest, from new-laid eggs and downy infants, to fully feathered youngsters; and there is every probability that the last eggs of the clutch are actually hatched by the combined warmth of their elder brethren and parent. A second brood is often reared in the late summer, eggs and young being present sometimes as late as December.

The Brown or Wood Owl (*Strix aluco sylvatica*) is fairly common in well-wooded districts, for it especially loves the seclusion of ancient hollow trees. Its general colouring is tawny-buffish brown, and in flight it appears as a large brownish-grey bird with rounded wings and a markedly large head. Its most familiar call is a melodious long drawn

quavering "hoo-hoo-hoo-hoo"; but it also has a short sharp clicking call-note—"Ke-wick! Ke-wick!"—most frequently to be heard in early summer after the young have left the nest, and probably may be used as a call to the youngsters to bring them to a meal. The Brown Owl is a valuable friend to the farmer, for 82 per cent of its food consists of mice, rats, shrews, and voles; 5 per cent of injurious insects; and the remainder of small seed-eating birds, mostly sparrows, together with worms and slugs.

The favourite breeding site of the Brown Owl is a good-sized hollow in the trunk or large limb of an ancient oak or beech, though occasionally it will utilise the old deserted nest of a rook, magpie, or heron, or a squirrel's drey. Like the Barn Owl, incubation begins before the full clutch has been laid, generally directly the first egg has been deposited, the remaining three or four being laid at intervals of two or three days. The young are generally hatched in April, and, when fully fledged, continue to perch among the branches of trees in the neighbourhood of the nest before finally taking leave of the old home, being fed during this interval by the old birds.

The Long-eared Owl (*Asio otus otus*) gains its popular name from the curious tufts of feathers upon each side of the head, which can be erected or depressed at will. The bird is fairly widely distributed in England, frequenting woodlands, and particularly fir plantations and isolated clumps of pines. During the daytime it stands erect upon

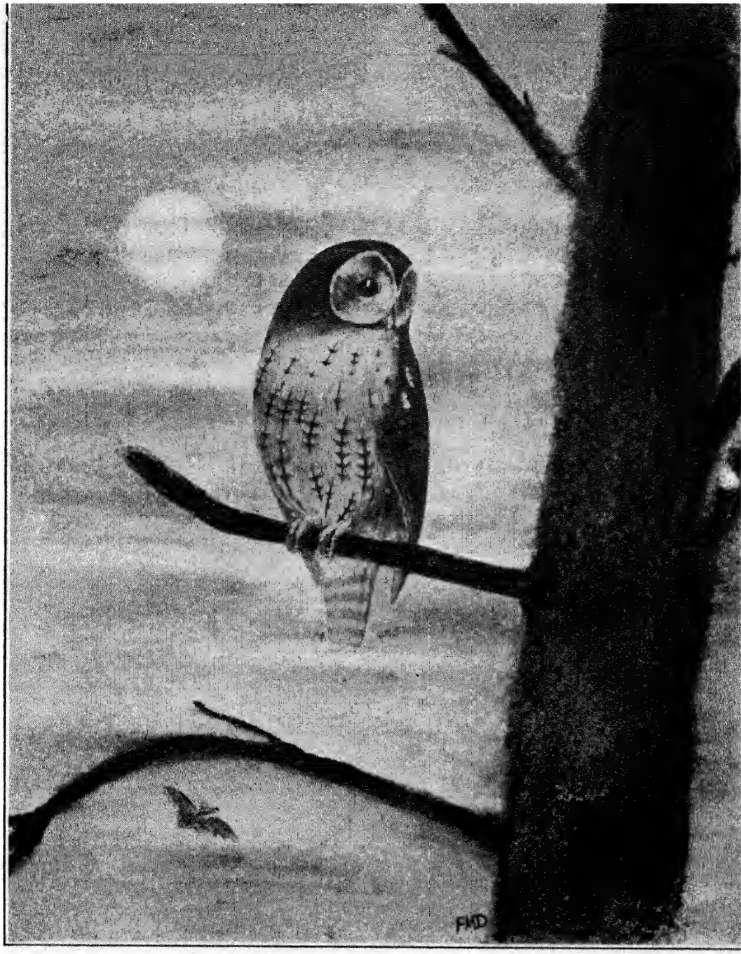
a bough, with its slender body pressed closely against the trunk of the tree, so motionless that its soft brownish colouring makes it look like a slight swelling of the trunk. This colouring and pose combine to make the bird very difficult to detect, a condition that is most desirable for its peace of mind; for should any small bird spot the Owl it will at once give voice, and in a very few moments all the small birds in the neighbourhood will gather round and mob and pester the Owl, apparently quite well aware of the fact that during the hours of bright daylight they have little to fear from their nocturnal foe, whose eyes are dazzled by the sunlight.

Haunting woodlands and plantations where coniferous trees are numerous, the Long-eared Owl breeds in old magpies' nests, or those of the wood-pigeon, rook, crow and heron, as well as old squirrels' dreys. From four to five eggs are laid at intervals of about two days about the middle of March or early in April. Normally, the call of this bird is a low long-drawn cooing moan, a continuous "oo-oo-oo-oo," which, when the nest is approached by an unwelcome visitor, changes to sharp "woof-woof's" and "oo-ack, oo-ack's"; while the cry of the hungry nestling resembles closely the noise of an old gate whose hinges are badly in need of a drop of oil. The woodland holds few more charming and amusing sights than a family of young Long-eared Owls, all sitting close together upon a bow high up on an old Scotch fir, for their attitudes and expressions when unalarmed are most comical to behold.

Of the food of the Long-eared Owl, 90 per cent helps to keep down foes of the farmer and poultry-keeper: 78 per cent being composed of mice, rats, and voles, and 12 per cent of seed-eating birds, of which sparrows form a large proportion. In addition to our native resident Long-eared Owls, considerable numbers from time to time cross the North Sea to our Eastern coasts of Lincolnshire, Norfolk and Suffolk, in the months of November and December. Although they are only winter visitors, it is probable that some may decide to take up residence in this country, and in this way the stock is increased and improved by the introduction of fresh blood.

The Short-eared Owl (*Asio flammeus flammeus*) is quite different in habit to all the British Owls we have so far considered, being far more often seen abroad during the hours of bright daylight. Moreover, it is not arboreal in habit like the others, but spends its resting time on the ground, frequenting open country, wild commons, moors and marsh lands at all seasons of the year. The general colouring of this handsome little bird is of a varying rich tawny-buff to palish buff, streaked with blackish brown.

The nesting site of the Short-eared Owl is a mere shallow depression, scraped among heather or coarse grass on the moorland and sand dunes, or a space trampled among sedges and dead reeds in the marshlands. It is interesting to note that although normally this bird only rears a single brood each year, in years of vole plagues, when the supply of



"Once I was a Monarch's daughter,
But am now a nightly rover,
Banished to the ivy-tree."

THE BEAVER PEELING BARK FROM AN ALDER BRANCH

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of its natural food is consequently superabundant, two broods will be reared. An examination of the castings or pellets ejected by the short-eared Owl show that 75 per cent of its food consists of mice, rats, and voles, 9 per cent of seed-eating birds, the rest of the bill of fare consisting of injurious insects.

Prior to 1842 the Little Owl (*Carine noctua*) was only a visitor to our shores, but since that date numbers have been turned out on private ground belonging to bird lovers, and these and their descendants have now become firmly established and have spread all over the country. They are most quaint and amusing little birds, and make very delightful and interesting pets. One that I had for some years became quite tame and friendly, walking about my study with an air of great solemnity, perching on my chair or bookcase, and giving vent to curious querulous little cries, rather like the asthmatic yaps of an overfed lap-dog, when it thought it was not receiving due attention. This bird nests in old farm buildings, quarries, hollow trees, rabbit holes, and old willow stumps. Late in April or May three to five eggs—occasionally as many as seven—are deposited, and both the male and female birds take part in their incubation. Family parties keep together for some weeks after the youngsters have become fully fledged and have left the nest. Like the Short-eared Owl, this bird is somewhat diurnal in its habits, and is often to be seen abroad during the hours of daylight, and on this account has been all too hastily credited with

taking toll of pheasant chicks. But really it is very doubtful indeed if the Little Owl does any harm to game, for the careful examination of its castings at all seasons of the year, and over a very wide area of country, has failed to reveal definite evidence against it. Indeed, it has only served to fully establish the fact that this bird devours enormous numbers of insects of all kinds that are injurious to the farmers' crops, in addition to field mice, rats, voles, sparrows, and earthworms.

Such, briefly, is the story of our commonest native Owls, and I hope that it is one that will convince my readers of the extraordinary interest and value to the community of these beautiful and harmless birds.

THE BEAVER, MASTER-CRAFTSMAN

THE Beaver is a master-craftsman; indeed, I am strongly tempted to call him *the* master-craftsman of the animal world, for he knows how to construct a house that is not only a comfortable, weatherproof, sanitary home, but a fortress that will protect him from most of his foes. He constructs dams that will withstand the rush of flood-water coming down stream from the melting snows with the return of spring; and excavates canals for the convenient portage of food supplies to his house, and can drive long tunnels through the soil with the precision of a skilled engineer. He is a most harmless, peaceably disposed creature, preying upon no bird, beast or fish, for his diet is entirely vegetarian; and he is a real hard worker, clean and methodical in his habits, devoted to his family. Unfortunately for the Beaver, he is the owner of a most beautiful thick, furry coat, a possession that has, within the last hundred years, well nigh led to the extinction of his race at the hands of so-called civilised man. For many a fertile valley among the hills of North America, where to-day the human settler has made his home and harvests luxuriant crops, the Beavers of the past were responsible; their labours of dam-building and tree-felling having brought about that rich deposit of soil.

There was a time when the Beavers must have been very common throughout our own countryside, for their bones have been found in Cornwall and Devon, Somerset and Dorset, northwards to Wales and Scotland. Moreover, the British Beaver's memory is enshrined in many place-names, such as Beverley in Yorkshire, which also includes the Beaver in its Coat-of-Arms; Beavercoates, Notts; Beaverbrook, Wilts; Beaverstone, Gloucester; and Beverley Brook, Battersea, mentioned as Beferith in an old charter dated 693 A.D.

When the last of the Beavers disappeared from Great Britain it is hard to say, but Gerald de Barri, better known as Geraldus Cambrensis, travelled through parts of Wales in 1188, and wrote his observations of the Beaver there and of the construction of their homes: "said to be built of willows and other kinds of wood, and different kinds of leaves, so that in course of time their habitations bear the appearance of a grove of willow-trees, rude and natural without, but artfully constructed within." Probably by the end of the thirteenth century the British Beaver had become extinct. Once common over practically the whole of the forest regions of Europe, to-day the Beaver is only to be found in south-western Norway, in the Elbe and the delta of the Rhone, in each of which localities it is, "as far as possible," closely protected. Nor has the American Beaver shared a better fate.

Prior to the arrival and settlement of the White man, the Beaver ranged over practically the whole of North America, with the exception of certain

southern portions, extending northwards to the limits of the deciduous trees, really to that of the Aspen, well north of the Arctic Circle. Over much of this great area the Beaver has been ruthlessly exterminated, and in much of the remaining country its numbers are greatly diminished. However, some steps have been taken, ere it is too late, to protect, and even to reintroduce the Beaver into some of its former haunts, so that there is some hope for the survival of this inoffensive animal in the northern United States and northern Canada.

The Beaver is one of the largest representatives of the rodent family, to which the squirrels, rats, mice, and similar animals belong. It is a stoutly built, compact animal, measuring when full grown about forty to forty-five inches or more in length, of which the remarkable, broad, flat, scaly tail will occupy some twelve to fifteen inches. The colour of its body is a rich dark brown, the under parts being somewhat lighter in tint. The eyes are small and bright, quick to detect a moving object. The ears are short, lined with fur, and have a valvular mechanism like the small nostrils, for complete closure when the animal submerges and swims below the surface of the water. The fore-paws are small with fairly long claws, and are used as hands for digging, but are not webbed, as they are not used at all for swimming. The hind foot, however, is long and webbed, and has long strong toes, of which the two inner ones have highly specialised nails, known as the "combing claws," and used by the Beaver in performing its toilet. It is with the

powerful hind feet and tail that the Beaver swims. Lastly, but by no means least, we must notice the two large front teeth in each jaw, called the incisors. These are the tools with which the Beaver does its wood-cutting, and are wonderfully adapted for the purpose. They are bright orange-red in colour, and continue growing during the whole life of their owner. Their front sides are composed of a layer of very hard enamel, backed by a thin layer of comparatively soft dentine. As the tooth is used the dentine wears away much faster than the hard enamel, so that there is always a keen cutting chisel edge at the front of the tooth. Beavers are devoted parents and appear to mate for life.

And now let us try to make out something of the daily life of this little master-craftsman, amid his natural surroundings on a shallow stream that finds its way through some quiet remote valley between the foothills of the famous "Rockies" of Canada.

The first faint flush of dawn was spreading over the eastern sky as two very weary, very frightened little furry travellers stole quietly up stream, keeping to the shadows cast by its banks for greater safety, and entered what must have seemed to them a blessed sanctuary, a valley of peace surrounded by high hills, whose slopes were still clad with a virgin forest of larch and pine, maple, birch and aspen. Poor waifs of the wild, they had for several weeks wandered afar up many streams, fleeing with terror in their hearts, sole survivors of a once flourishing and happy Beaver colony; their one desire to find

some sanctuary far from their cruel and relentless foe—Man. Again and again in their wanderings they had paused for a day or two in some apparently likely spot, only to pick up traces of the presence of the enemy. So they had journeyed on through the warm, scented summer nights, resting beneath some friendly fallen tree, or in some hollow in the banks of the stream during the hours of daylight—for long persecution has taught the Beaver the danger of being abroad when the sun is in the heavens—resuming their weary pilgrimage as the soft mantle of the night spread over mountain and valley. Guided by that wonderful and mysterious sense, of which we really know nothing, and in our supreme vanity of ignorance so glibly term "instinct," these children of the wild had found their way right into the heart of a great virgin tract of hilly country as yet untouched by man, and here, in this quiet valley of peace, they would make their home.

It was an ideal situation; the little stream wandered slowly through the valley between low banks, and one part of the valley spread out in marshy luxuriance where a spring welled up and drained away into the main stream. Aspen, birch and willow were in abundance, so that a plentiful food supply was at hand, while towards the foot of the valley there was a spot where at some period a landslide had occurred and a convenient place formed for the building of a dam.

But why should the Beavers wish to build a dam? Well, the primary object for building one is that

an artificial lake may be formed and the water maintained at a constant level in order that the entrances to their home shall be always surrounded by a sufficient depth effectually to prevent any of their land foes gaining admittance, and that they may have a place of retreat in the event of an attack on their home.

Once our little friends had decided that all was well and this quiet valley a safe sanctuary, they began operations on the construction of the dam. With their sharp, chisel-like teeth they felled a number of alders, cut them into convenient lengths, and laid them lengthways with the banks and with their butt-ends pointing upstream, in regular order, right across the shallow stream. Every night more logs and branches were added, with clumps of sod and mud well worked in on the upper side, until the dam stretched right across the shallow bed of the stream, and extended far beyond, completely closing the narrow neck formed by the landslide on the one side and rising ground on the other. A dam can never be truly described as finished, however, for so long as the Beavers have their home behind it they are continually adding to both its height and length. However, at the end of a few weeks of steady nightly labour our beavers had constructed a dam some thirty feet in length and over two feet in height, which was sufficient for their first winter's needs, to surround their home with flood water and give them safety.

Once the dam had begun to hold back the stream, causing the water to deepen, the Beavers decided

Beavers Adding Fibrous Material and Sods to strengthen the Dome-shaped Nest

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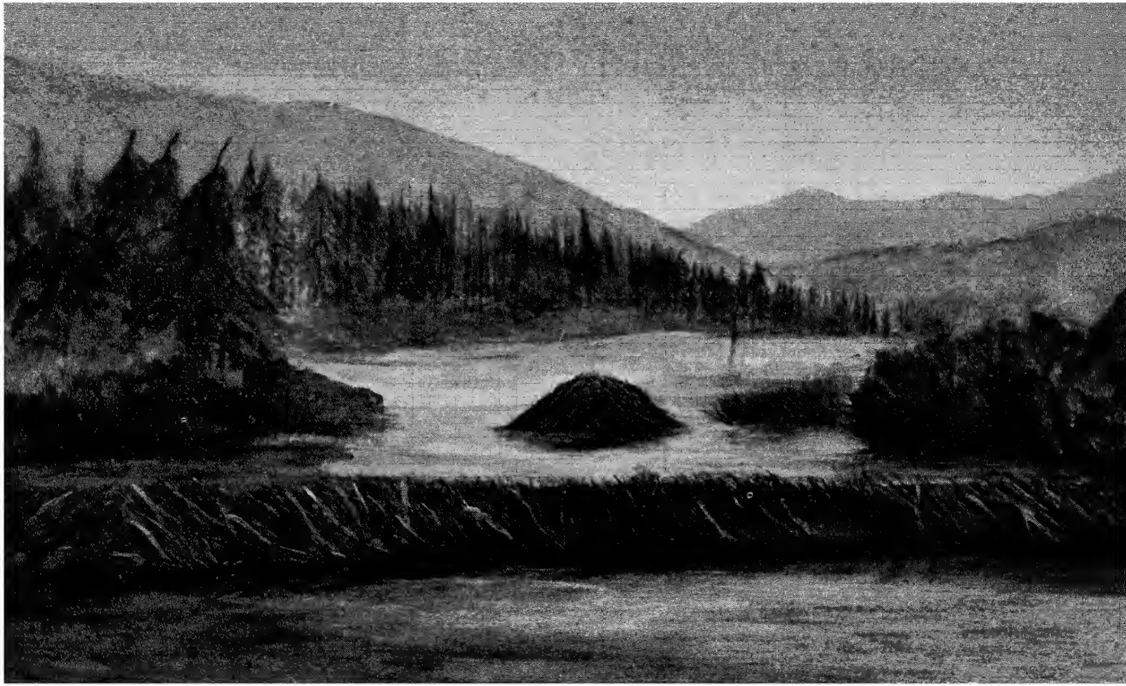

THE DOME-SHAPED NEST AND BRUSHWOOD DAM COMPLETED, OUR LITTLE FRIENDS ARE SNUG AND SAFE

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on the site for their home, a low hillock on the marshy side of the stream near where one of the springs welled up, which was already becoming surrounded by the rising waters and made into a miniature island. As the earth on the hillock was fairly soft, a burrow was easily made, which extended downwards at a comfortable angle, starting at the centre of the hillock and finally opening under water. The next business was the collection of material for the building of their home. Saplings were felled, cut into convenient lengths and hauled up on to the hillock, and from these they stripped and ate the bark, thus reducing their labours, for the single cutting of branches served two purposes. They also collected some of their building materials from the dead branches which had been floated by the rising waters. Among the dome-shaped network of sticks accumulating on the mound they worked in large quantities of fibrous material and sods grubbed up from the marsh and the bottom of the stream near their home, carrying it in great armsful and forcing it into position with their front paws and noses. Although at first sight the branches and sticks appeared as if laid in a very haphazard manner, the Beavers really worked methodically, always striving to make a dome of tangled material, so closely woven as to be very difficult to tear apart. This erection grew with surprising speed, and within two or three weeks had reached a height of nearly four feet and a circumference at its base of close upon twenty feet. Nor had their labours been confined entirely to the outside, for within this

brushwood pile the material had been cut away over the land entrance to the burrow, leaving a domed cavity two feet high and nearly five feet in diameter. After they had completed this chamber, they decided to excavate a second burrow, as an emergency exit in case some unwelcome visitor, such as an Otter, might ascend their first burrow, for he is the only aquatic foe the Beavers dread.

By the time all this work was completed, the Beavers found themselves in possession of a substantial, safe, and comfortable home.

But the summer was already fast drawing to a close, and much had still to be accomplished if they were to survive the terrible cold of the long winter in comfort. So now the busy pair turned their attention to collecting food supplies to last them through the long winter months, when all the valley would be buried under snow and ice. With this end in view the Beavers set off on a tour of inspection along their valley, and began felling young aspen trees, the bark of which constitutes, in the Rocky Mountain region, their favourite food. Young birches were also felled for the same purpose. The trees selected averaged at their base three or four inches in diameter, though some much larger trees were felled later. As soon as a tree was down the Beavers proceeded first to cut off all the branches, close to the stem, and to transport them downstream to the vicinity of their house, close to which they had decided to form their woodpile. On arriving at the selected spot with a branch in tow, the Beaver would at once dive down and

ram one end securely in the mud at the bottom of the pond; for the water now, thanks to the action of the dam, entirely surrounded their house, forming a miniature lake. The slender trunks were cut into sections four to eight feet in length and in turn transported to the ever growing wood-pile. The nights were now rapidly lengthening, so that the Beavers were able to work longer hours, and at dawn entered their home thoroughly tired out with their labours, and glad to sleep and rest until the long shadows of evening once more called them forth to their work.

There were nights, however, on which no tree-felling could be done, owing to the presence of foxes or wolves or other four-footed foes in the wood. Always while at work the Beavers were on the alert for the approach of any enemy, sitting up and sniffing the air from time to time to pick up with their keen sense of smell any scent of prowling fox, lynx or wolf, scuttling off to the safety of the water directly any suspicious scent or sound was detected. If, on approaching the shore, one of them detected danger, the Beaver would instantly bring its broad flat tail down with a resounding slap on the water as a warning to its companion, and dive beneath the surface, not reappearing until far out in the middle of the lake, when the little head would be cautiously raised above the surface, ears and nose strained to catch the faintest scent or sound.

But on these nights when the woods were unsafe, the Beavers did not remain idle. Diving down,

they grubbed away at the sods and mud at the bottom of the pond, bringing up great armsful with which they began to fill in and plaster over the whole of the outside of their house, and also used this material to strengthen the upper face of their dam. Working in this way, they very effectively increased the depth of water in the immediate vicinity of their home, so that when the season of frost came round and the whole surface of the lake would be frozen over, they would still be able to swim beneath the surface of the sheet of ice to their sunken wood-pile and bring back supplies of food. As each coating of mud plastered on the outside of their house contracted under the influence of the now nightly frosts, another coat was applied, until the exterior of their home looked like a great mud heap, which as it became frozen grew immensely strong on the outside and snug and warm within.

Autumn transformed the slopes of the hills and all the valley into a pageant of gold and bronze, crimson and scarlet, while the Beavers worked on with tireless energy, bringing in more food supplies of alder, birch, and maple, until their winter wood-pile covered an area over sixteen feet in diameter and six feet in depth. Colder and colder grew the nights, the golden and scarlet glory fell down from the branches and formed a rustling, russet carpet to the woods. Gradually the surface of streams and lakes became completely frozen over, and all the world lay silent under its deep mantle of snow, only a slight white mound indicating the position of the Beavers' house. Within their snug home the

Beavers were now reaping the reward of all their labours and foresight. No matter how the winds might rage without, and blizzards sweep across the hills and valleys, causing devastation in the woods, our friends were safe and enjoying well earned repose; safe, too, in the knowledge that no wolf, lynx, or wolverine could make any impression on the ice-bound walls of their home. Most of the time they probably spent in sleep, only occasionally quitting their home, by one or other of the two tunnels, for a swim in the ice-covered lake to bring back a supply of twigs and branches from their submerged wood-pile. When the bark had been stripped off and eaten, the peeled branches would be carried out of the lodge and left floating beneath the ice-sheet.

So the long winter passed peacefully and uneventfully for our little friends. With the return of spring, and the melting of the ice and snow, the valley awoke to the sound of tinkling waters, whose volume increased hourly and threatened the total destruction of the dam, and even forced a way through at one point, which the Beavers repaired directly the great flood had passed. By the time that the first signs of tender green began to show as a filmy haze in the woods, the little female Beaver had given birth to a litter of three soft, furry little babies, whose faint whining cries resounded through the house. For the first two or three weeks she kept them close within the safe shelter of their home, and then, on one mild spring afternoon, permitted them to follow her down the tunnel and

enter the water for the first time, and have a short peep at the great, bright outside world.

Spring gave place to summer, and the youngsters grew and throve amazingly, so that by the time autumn came round they were able to lend willing aid in the labours of repairing the house and dam, and in collecting food supplies for the coming winter. And here we must leave our little friends, firmly established in their peaceful, happy valley.

THE OCTOPUS AND CUTTLEFISH

With their large unwinking eyes and sucker-clad writhing arms, the Octopus and Cuttlefish are grotesque looking creatures, sufficiently uncanny to awaken a natural feeling of fear or repulsion. From the earliest times they have attracted attention, and during the Middle Ages a wealth of fable was gradually accumulated concerning their size and habits. To the ancient Greeks and Romans both Cuttlefish and Octopus were familiar objects, the latter being esteemed as an article of food, as indeed it is to-day along the shores of the Mediterranean. Therefore, it is not altogether surprising to find that the great philosopher, Aristotle, who flourished 322 B.C., left among his writings a wonderfully clear and accurate description of these creatures. The fables were chiefly of later origin, and are to be found in writings of the twelfth century onwards, in the accounts of two fearsome sea monsters, the Devil-fish and Kraken.

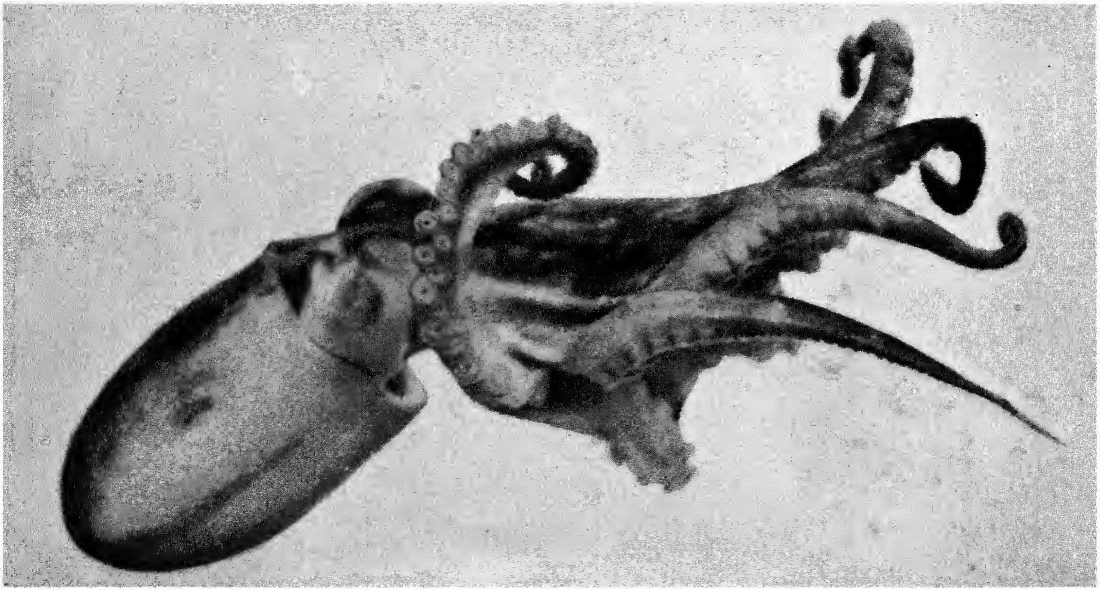
Both the Octopus and Cuttlefish belong to the Mollusca—that great division of the Animal kingdom which includes the Oysters, Cockles, Mussels, Whelks, Clams, Snails and Slugs. They differ, however, from the majority of their connections in a marked degree, both in their structure and

habits, and are placed in a special class called the Cephalopoda, or "Head-footed." This name (which is taken from two Greek words) has been given to them from the fact that all the members of this class are distinguished by having their feet growing out from the head, arranged in a circle of sucker-clad limbs surrounding the mouth.

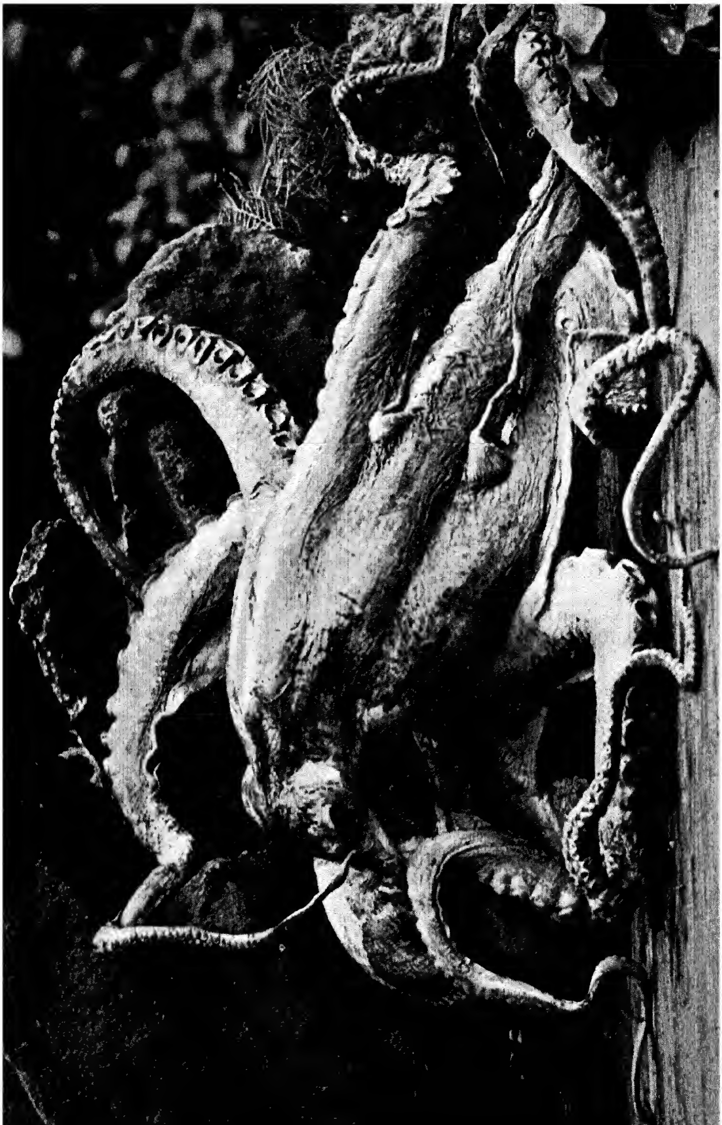
On these curious feet, which are usually spoken of as arms, the Cephalopods crawl about, head downwards, at the bottom of the sea. They swim well, moving slowly forward, using their arms as paddles, or shoot rapidly backwards through the water, by ejecting with great force a stream of water from a short tube which projects from the opening of the mantle on the under side of the body. They are, for the most part, fairly active creatures, extremely fierce and pugnacious in their ways; some of the larger species being fearsome monsters, much dreaded by fishermen and divers, whom they not infrequently attack.

The Cephalopoda are grouped together in two orders. The Dibranchiata, which have two gills; and the Tetrabranchiata, which possess four. Those in the first division, which contains the Octopus, Cuttlefish, and the Paper Nautilus, are again divided into "Octopods" and "Decapods"—the former having eight and the latter ten of the curious head-foot appendages. The second division is represented by a single species, the Pearly Nautilus, which differs in several particulars from the two-gilled Cephalopods.

The members of the Octopus family have a muscular sac-like body, to which is joined, by a short



The Eledon, or Lesser Octopus, in the Act of Swimming



THE OCTOPUS AT HOME

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waist, a large, roundish, well-developed head. They have no shell, or this may be represented by two small plates entirely hidden within the folds of the mantle. Water is admitted to the gills through a wide aperture beneath the head, and below this is the short, funnel-shaped tube, or siphon, through which water is discharged; and also, occasionally, an inky fluid from a special gland, or ink-bag, with which the Octopus is provided. This ink is ejected by the animal when it is excited or alarmed, particularly when it has had the worst of an encounter with some other monster of the deep. Then, violently squirting a volume of inky fluid in the face of its astonished foe, the Octopus beats a hasty retreat under cover of the dense "smoke-cloud" it has created in the water.

Arranged round the mouth of the Octopus are the eight long tapering arms, connected at the base by a broad, membranous band. This, in some species, extends far up the arms, and resembles an umbrella. Each arm is provided with two rows of suckers, extending down its entire length. They are largest at the base of the arm, and gradually diminish in size until they reach the tip. These suckers are most remarkable structures. Each consists of a round, muscular disc, with a raised margin. In the centre of the disc is a hollow cavity, wider at the bottom than at the top; and within this cavity is a soft, fleshy button called the "caruncle," which works up and down like a piston. Now when the sucker comes into contact with an object, this piston is at once withdrawn, and a perfect vacuum is

produced. So firmly do these suckers adhere to anything on which they have fastened, that it is easier to tear the arm from an Octopus than to make it relax its hold. Small chance of escape has any unhappy victim, once it is clutched in the cruel embrace of those terrible sucker-clad arms.

In the centre of these formidable arms is the mouth, furnished with a pair of strong horny jaws, shaped like a parrot's beak. Within the mouth is a long slender tongue, or radula, beset with several rows of sharp pointed teeth. This tongue is used to rasp the food, which has first been torn to pieces by the powerful beak.

The Common Octopus (*Octopus vulgaris*) is a somewhat sluggish animal. During the daytime it hides itself away in some rocky cranny, or hangs suspended to a rock by some of its arms, while the others gently wave to and fro in the water ready to seize any luckless creature that comes within their reach. Fishes, crustacea, molluscs, all fall victims to this sea ogre, and its retreat may often be discovered by the empty shells and other debris which lie strewn about the entrance to its den. But as night falls the Octopus ventures forth, creeps about on the floor of the sea, or propels itself slowly through the water by opening and shutting his umbrella, its bright eyes always on the watch, seeking whom it may devour. Then, at dawn, its appetite satisfied, it slinks back to its hiding place to rest and digest its meal.

Few sea creatures, one would imagine, would be bold enough to tackle such a monster. Nevertheless,

both the Octopus and Cuttlefish are hunted and devoured by sharks, dogfish, giant conger eels, and certain species of whales. Occasionally, after a battle royal, the Octopus will escape minus an arm or two; this, however, is no great loss, as, like many other denizens of the deep, Cephalopods have the power of growing new limbs.

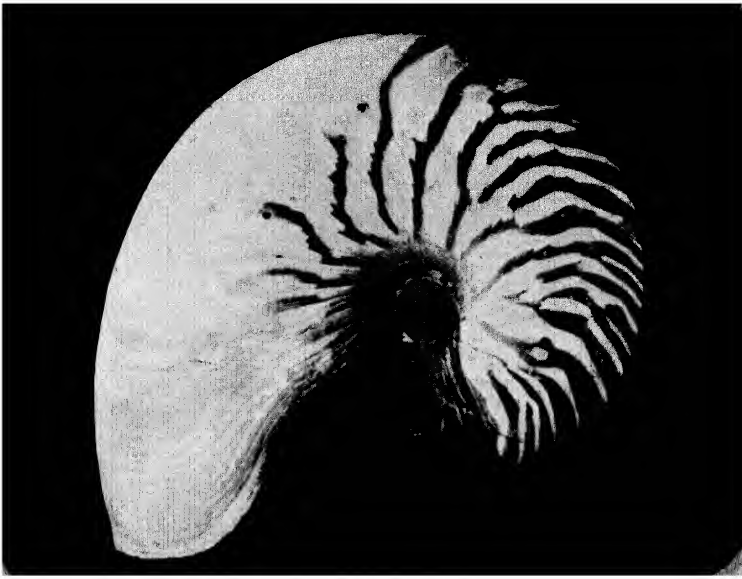
Although such a fierce, remorseless creature, the female Octopus is a model parent. She deposits forty or fifty thousand eggs at a time, and these she guards and cares for with the greatest solicitude until the young are hatched. The eggs are clustered together in huge masses, resembling bunches of grapes. There may be forty or fifty of these bunches, and mother Octopus constantly passes from one to the other, folds them in her arms, and sprays them with water from her siphon; seldom leaving them except to obtain food. Constantly on the watch for danger to her offspring, she will furiously attack any prowling creature that ventures near—including father Octopus, should he be unwise enough to pay a visit to his wife while she is occupied with the cares of her nursery. Indeed, if too persistent, he may pay for his intrusion with his life, for, exasperated by his attentions, mother Octopus will fall upon her mate, slay, and devour him!

The eggs take about fifty days to hatch, and the young Octopods, when they make their escape, are about the size of a large flea. Unlike most of the Mollusca, they undergo no marked transitional stage, but are fully developed when they emerge from the

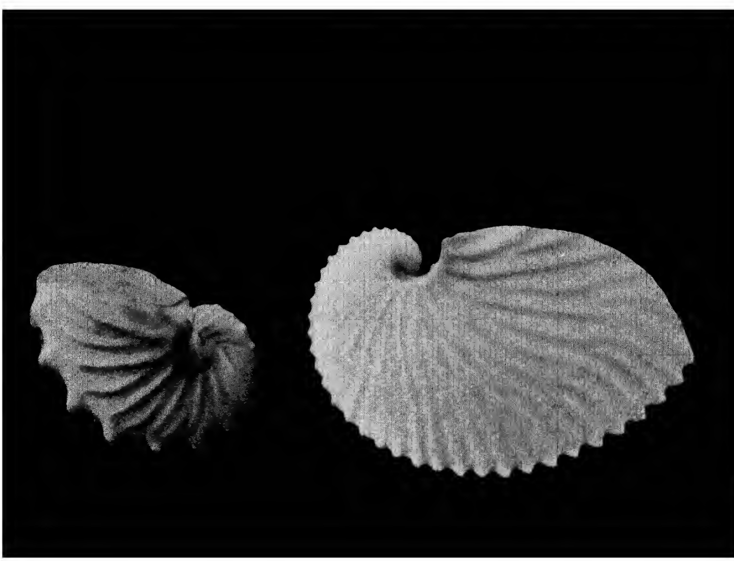
egg, their arms showing as a circle of budding outgrowths round the heads of the tiny creatures. They rise at once towards the surface, where they disport themselves for a while in the sunlit waters, before settling down for life at the bottom of the sea.

The Octopus frequents rocky shores, and different species are found round the coasts of almost all tropical and temperate seas. Those on the British coasts are usually of small size—a specimen with arms two feet long would be considered unusually large. In warmer seas, however, they are often considerably bigger, but they never grow to the gigantic proportions some travellers would have us believe. The Eledon, a small Mediterranean species, is not infrequently seen on the British coasts. It differs from most of the Octopus family in having only one row of suckers on its arms instead of two. The Pinnoctopus, which inhabits the coasts of New Zealand, measures over three feet in length, and is distinguished by having a pair of broad fins extending from the sides of the body.

Very different in appearance from other members of the Octopus family is the Argonaut, or Paper Nautilus. It is a small creature and possesses a beautiful external shell, which, unlike the shells of other molluscs, is not attached by muscles to the body of the animal, but is held in position by two of its arms, which are specially adapted for this purpose. These arms not only clasp the shell, but secrete the substance of which it is composed, and repair any injury that may arise.



THE SHELL OF THE PEARLY NAUTILUS
Sole living representative to-day of the four-gilled Cephalopods



THE DAINTY FRAGILE SHELLS OF THE ARGONAUT OR PAPER NAUTILUS

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A Stranded Cuttlefish

Note the two long arms or tentacles with their spoon-shaped, sucker-clad ends.

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Fairly abundant in the Mediterranean, the little Argonaut must have been a familiar object to the ancient Greek voyagers, and it was Aristotle who described it as floating on the surface of the sea, in fine weather, and holding out its sail-shaped arms to the breeze, sailing along like a miniature ship upon the bosom of the ocean. This delightful but quite inaccurate description of the animal's mode of progress is exquisitely pictured in the following lines by James Montgomery in his "Pelican Island":

> "Light as a flake of foam upon the wind,
> Keel upward from the deep emerged a shell,
> Shaped like the moon ere half her horn is fill'd;
> Fraught with young life, it righted as it rose,
> And moved at will along the yielding water.
> The native pilot of this little bark
> Spread to the wafting breeze a twofold sail,
> And mounted up and glided down the billow
> In happy freedom, pleased to feel the air,
> And wander in the luxury of light."

Alexander Pope would also have us—

> "Learn of the little Nautilus to sail,
> Spread the thin oar, and catch the driving gale."

Alas, in real life the Argonaut swims backwards in the surface waters of the sea by ejecting water from its siphon funnel in the same manner as the Cuttlefish and Octopus, and crawls about on the floor of the ocean in as prosaic a fashion as a common garden snail.

The Decapods (the Cuttlefish or Squids) differ in many ways from their Octopod relations. In addi-

tion to the eight arms surrounding the mouth they have two very long arms or tentacles which spring from the centre of the circle. These two arms are sometimes three times the length of the creature's body, they are destitute of suckers except at the tips, which are club-shaped and thickly covered with them. The suckers are mounted on short stalks, and surrounded by a hard, horny ring, having either a smooth or sharply toothed rim; while in some species they are further armed with long curved claws, which are retractile, like the claws of a cat. The eight encircling arms are shorter than those of an Octopus, and are clad on the inner surface with several rows of suckers. The Cuttlefish also has an ink bag, and its jaws are very similar to those of an Octopus, though not quite so large in proportion to the size of the animal's body. Decapods possess an internal shell, which varies in size and form in different species. In the Sepia the shell takes the form of a flat, calcareous plate, which is popularly known as the "cuttle bone," and may often be picked up on the seashore; while in Loligo (the Pen-and-Ink fish) the shell is reduced to a thin narrow plate or "pen," as it is called.

Cuttlefish lead a more active life than their Octopod relations. Instead of hiding away in the daytime, they swim about near the surface of the sea, and often go about in large shoals—several hundred Cuttles being often seen together far out at sea. They sometimes visit the coast, where they do a great deal of harm, by destroying large quantities of fish; killing many more than they can devour,

Cuttlefish cut open to show the Plume-like Gills and the Ink Bag containing Sepia

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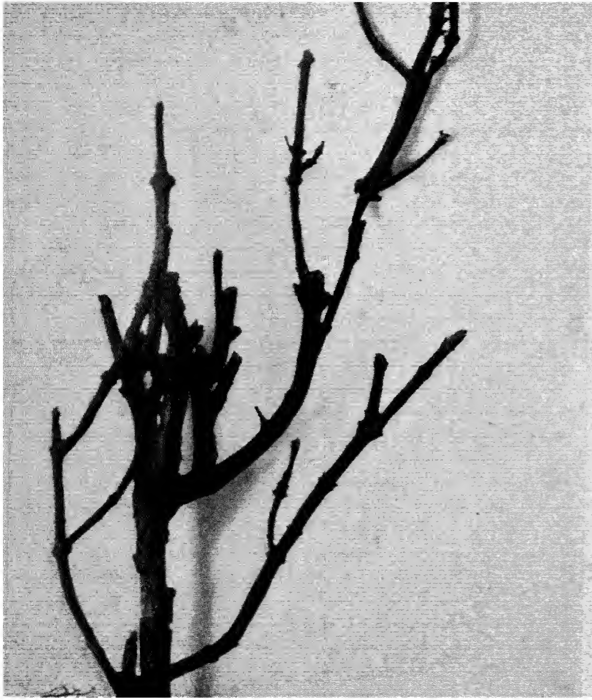
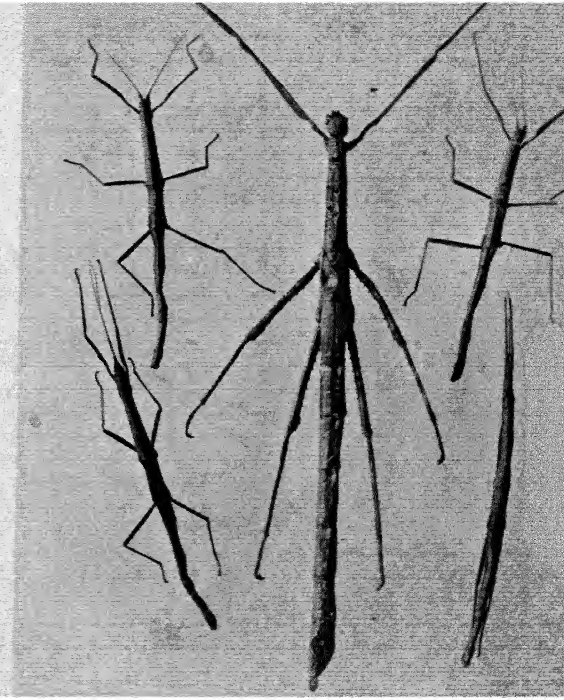
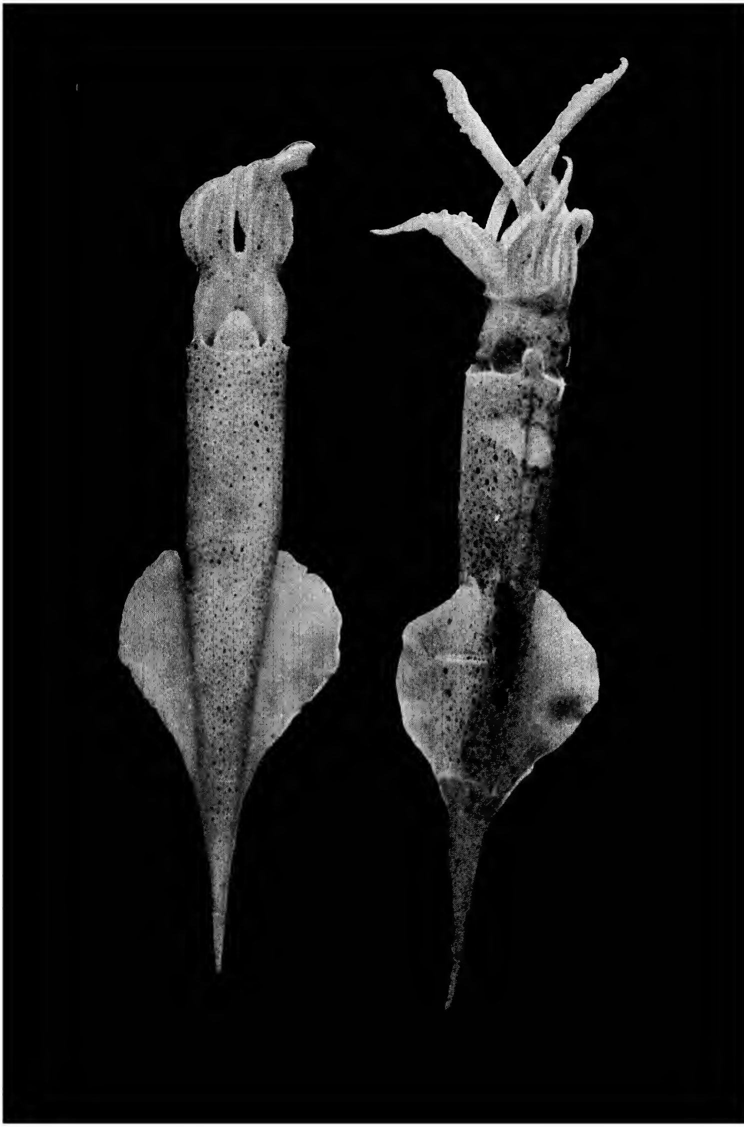


LOOPER CATERPILLARS
When alarmed remain absolutely motionless, resembling twigs in shape and colour



A GROUP OF STICK INSECTS



Loligo, the so-called Pen-and-Ink Fish, are slender, swift-moving Cuttles

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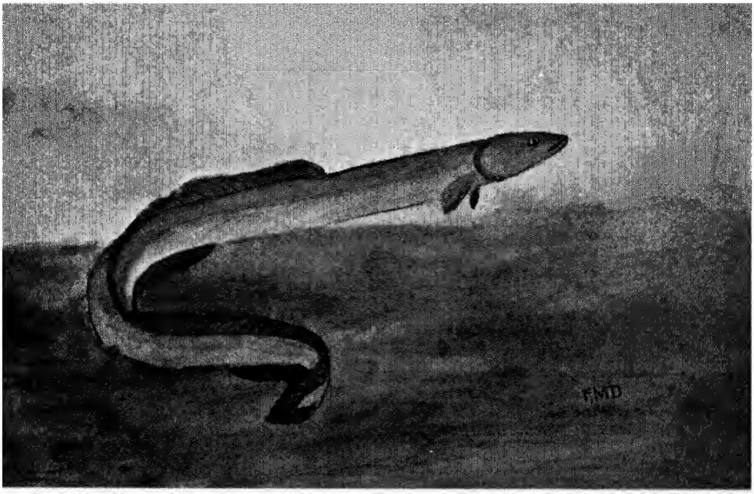
by biting them on the back of the neck. In America the Mackerel fisheries are sometimes ruined by the great schools of Squids that infest the inshore waters.

In size the different species of Cuttlefish vary to an extraordinary degree. The little *Sepiola atlantica*, which is not uncommon on the British coasts, measures no more than two inches, both in length and breadth; while some of the Calamaries, or Giant Squids as they are called, are enormous creatures, twelve feet or more in length, with tentacles over thirty feet long. Even larger Squids than this have been recorded, but their size is often greatly exaggerated, and many of the marvellous tales told of these monster Cuttles must be considered as travellers' yarns. In *Moby Dick* we have a thrilling account of an adventure with a giant Squid of most astounding proportions: "a vast pulpy mass, furlongs in length and breadth, of a glancing cream colour, lay floating on the water, innumerable long arms radiating from its centre, and curling and twisting like a nest of Anacondas, as if blindly to catch any helpless object within reach. No perceptible face or front did it have; no conceivable token of either sensation or instinct; but undulated there on the billows, an unearthly, formless, chance-like apparition of life." A truly appalling vision indeed! which, fortunately, we are not likely to encounter on a sea voyage. Vivid accounts, too, have been given of the terrific battles which take place between Giant Squids and their natural enemies, the great Sperm Whales; and

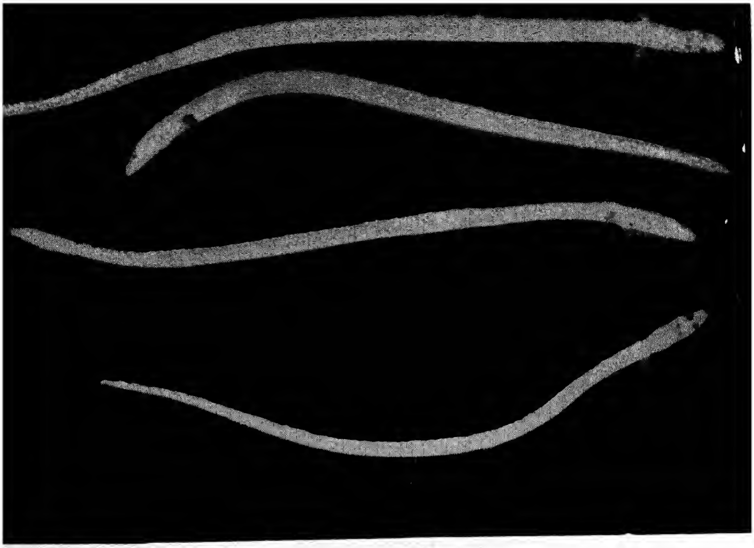
conflicts between these monsters of the deep do actually occur, for the Sperm Whale hunts and devours the Cuttlefish, which appear to constitute its chief food.

The Pearly Nautilus is now the sole representative of the four-gilled Cephalopods, although in bygone ages these interesting molluscs must have been fairly abundant in the sea. It lives among the coral reefs in the Indo-Pacific Ocean, spending its time mostly at the bottom of the sea, although after a storm it is frequently seen floating upon the surface of the water. The large and beautiful shell of the Nautilus has a smooth, porcelain-like surface, and is lined with mother-of-pearl. Within, the shell is divided into a number of chambers, by curved partitions called "septa," a membranous tube running through a perforation in each partition, connecting all the chambers together. These little compartments have been added to the shell one by one to accommodate the growth of the Nautilus; the animal, which is remarkably small in proportion to its shell, occupying only one, the last formed, of its suite of rooms. Round the mouth of the Nautilus are a number of small feelers, which take the place of the sucker-clad arms of the Octopus and Cuttlefish. There are about ninety of these feelers, and when they are extended from the mouth of the shell the Nautilus looks not unlike a sea anemone, or as Mr. Saville Kent described it: "a shell with something like a cauliflower sticking out of it."



An Adult Eel

The First, or Leptocephalus, Stage of the Eel
A tiny, flat, transparent creature that makes its way across the Atlantic to the coasts of Europe



THE SECOND LARVAL STAGE OF THE EEL
Young Elvers as they appear when coming up the rivers from the sea

A YOUNG EEL, OR ELVER

THE ROMANCE OF THE EEL

For centuries the life-history of our Common Eel remained a mystery, a subject for wild speculation and all sorts of curious theories. No one had ever seen Eels mating or depositing their spawn; nobody had seen a baby Eel just emerged from the egg. Small wonder, therefore, that, in days gone by, some very curious ideas were held concerning the propagation of the Eel. If we turn over the pages of some of the old books dealing with natural history that were written in the sixteenth and seventeenth centuries, we shall find that there was a very general belief that Eels arose spontaneously from the corpses of animals drowned in ponds and rivers, and also that they could be generated by steeping the hairs from the mane and tail of a stallion in a shallow muddy pool. Later on, when these fanciful ideas could no longer be entertained, they were replaced by a vague but very general belief that breeding took place in some instances at the bottom of the ponds in winter, and that a certain proportion bred in the sea.

Certainly it was a great puzzle, for Eels of all sizes were to be found at all seasons of the year, living in ponds, lakes, and rivers, yet no one had ever caught an Eel heavy with spawn; while even

experienced fishermen could not distinguish the sexes with certainty. The only established facts concerning the habits of the Eel were: that numbers in prime condition could always be caught descending the rivers to the sea every autumn, and that great shoals of tiny transparent Eels, or Elvers as they are popularly called, made their appearance at the mouths of the rivers every spring, and travelled up stream. Where the fat autumn Eels migrated to, or from whence the swarms of Elvers had come, no man could tell.

Here then, was one of those well-kept mysteries of Nature, the unravelling of which could only be accomplished by years of patient toil and observation. Bit by bit, during the last fifty years, evidence has gradually been accumulating, until at long last, thanks to the untiring study and investigations carried out by the great marine zoologist, Dr. Johs. Schmidt, of Copenhagen, the links in the chain have been connected up, the mystery solved, and the life-history of our Common Eel proved to be one of unique character and quite extraordinary interest.

Eels are often to be found in ponds and lakes which are situated at considerable distances from any river, and, to reach these isolated inland pools, the Eels must have made an overland journey. This they accomplished generally by travelling during the night, and in rainy weather, wriggling along over the damp earth and through the soaking herbage. Unlike most fish, the Eel can live quite comfortably out of water for many hours, or even

a day or two, for its gill-chambers, which form conspicuous swellings on each side of the throat, are specially adapted for retaining a supply of water, in which the delicate branchial laminæ, or breathing apparatus, float. So long as the gill-chambers are filled with water, the respiratory apparatus can function, and the Eel can journey through the fields and lush grass meadows without fear of suffocation. The profuse slime secreted by the skin, in addition to the mechanism of the gill-chambers for retaining a supply of water, renders it possible for the Eel to remain so long out of water.

The Eels found in these inland pools, and also those living far up the rivers, attain to a considerable size, specimens over three feet in length being occasionally captured. These are generally females, for the males are small, and always remain in the estuaries and lower reaches of the rivers, rarely ascending beyond the reach of tides. Although the sexual organs of both the male and female do not reach a recognisable size while the Eels are in the ponds and rivers, there are certain constant external features by which it is possible to recognise the sexes. Thus, the male is always smaller than the female, rarely exceeding seventeen inches in length, and has a broad head and snout—from which he is known to fishermen as a Rig or Broad-nosed Eel; while the female may attain to a great length, and has a narrow head and pointed snout.

Eels take a very long time to grow up, and the age at which the sexual instinct is reached may vary from five to twenty years or longer, climate

and food supply being important factors; and during all these years they feed voraciously, and steadily increase in size. At the end of this period they are in prime condition, their flesh is firm, and much fat is stored in their supple bodies. Finally, there comes an autumn when they have reached the zenith of size and strength, and, for the first time, there is a desire to leave their accustomed haunts and travel down to the sea. It is the awakening of the first sexual impulse, an irresistible command of Nature, calling them to their breeding grounds far across the ocean. So every autumn large numbers of Eels begin to pass down the rivers, not only of this country, but of Ireland, France, Holland, and Scandinavia, towards the sea. As the Eels start on their migration down stream, they change from their familiar yellowish dark green colour and take on a metallic sheen, while their pectoral fins become black and pointed. Large numbers of these so-called "Silver Eels" are caught in the wicker basket traps called "eel bucks," and, along the shores of the Baltic, in special nets set in shallow inshore waters.

Answering that imperative call of Nature for the propagation of their species, these migrating Eels pass out from the rivers of Great Britain, and of North and West Europe, into the North Sea and the Atlantic, shaping their course south-west with the same unerring precision that we are accustomed to associate with migrating birds, following the same routes as their ancestors have travelled for untold generations. The exact length of time that

this journey back to the ancient breeding grounds takes is not definitely known, for once the migrating Eels reach the open North Sea and Atlantic, they pass from our ken, and their rate of progress is unknown; but marking experiments carried out, chiefly along the coasts of Sweden and Finland, show that in those waters the Eels are travelling at a speed of at least nine miles a day. No matter how long the journey may take, however, all are migrating to an area far out across the Atlantic, to a region situated in the western Atlantic, at about 22° and 30° N. Lat., and about 48° and 65° W. Long., with its centre nearly equidistant between the Leeward Islands of the West Indies and Bermuda. Here, at a depth of 3,000 fathoms or more, spawning takes place; and, the continuation of the species thus secured, the parent Eels perish, having accomplished the supreme duty of their lives.

From the spawn deposited at this great depth below the surface of the ocean, the baby Eels emerge; curious perfectly transparent little creatures, measuring about a quarter of an inch in length, and not in the least resembling their parents, for their bodies are flat and shaped like a slender willow or eucalyptus leaf, and their heads are very small indeed. These little leaf-like, transparent creatures first began to attract the attention of marine zoologists in the early 'fifties of the last century, when they were called Leptocephali—literally, "small heads"—and various theories were propounded concerning them; for it was not until 1896 that two Italian zoologists, Grassi and Calandrucio, established

beyond dispute their identity as the young or larval stage of the Eel.

The spawning, which always takes place at great depths, begins in early spring and lasts well into the summer. The leaf-like young, or Leptocephali, grow rapidly during the first months of their lives, and in their first summer reach an average length of one inch. They then leave the great depths in which they were born and ascend towards the surface waters, swimming at depths of fifty-four and twenty-seven yards.

Aided by the eastward movement of the surface water, the little leaf-shaped transparent larvæ now begin their long journey across the Atlantic to the shores and rivers of Great Britain and Europe from which their parents migrated; a journey that will occupy the whole of the first three years of their lives. Their first summer finds them in the western Atlantic, west of 50° Long. W. By the second summer they have reached the central Atlantic waters, and have grown to some two inches in length. In the third summer they approach the coastal banks of Europe, have an average length of nearly three inches, and still retain their leaf-like shape and transparency. It is during this, the third autumn and winter of their lives, when they are approaching the shores of Europe, that they undergo the remarkable change, or retrograde metamorphosis as it is termed, which converts them from leaf-shaped creatures into tiny round-bodied, transparent Eels, or Elvers, as they are popularly called. This change of form completed, they move inshore along

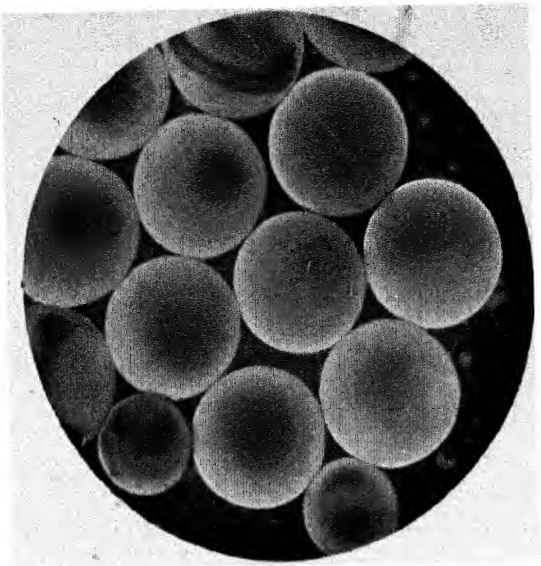
the coasts, and, in countless numbers during the spring months of the year, ascend the rivers and find their way far inland into ponds, ditches, and lakes—there to live quietly for years, feeding and growing, until the time comes for them, as adult Eels, once more to cross the Atlantic, on that last long journey which will terminate in parenthood and death.

The Eel is extraordinarily voracious, and, when present in considerable numbers in a river or lake, will seriously diminish the stock of other fish present. Eels devour the eggs and young of other freshwater fish, frogs, newts and aquatic insects. They are keen hunters, and will turn over flat stones, or worm their way under ledges of rock embedded in the mud, in their search for prey. As they will not touch tainted food, but pounce upon their living prey, the once common idea that they fed upon corpses and carrion is highly improbable.

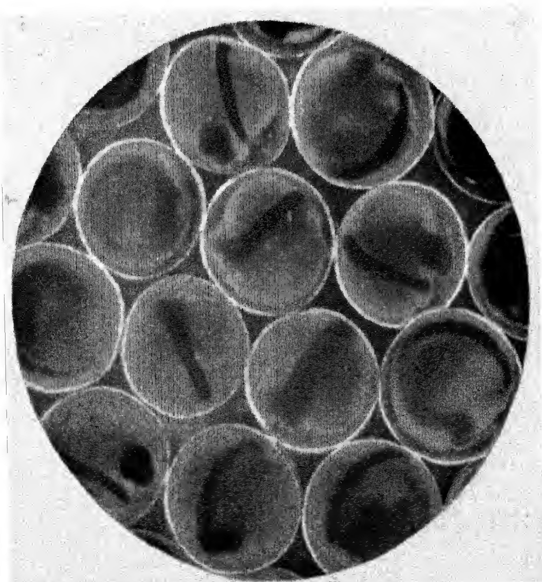
THE ROMANCE OF THE PLAICE

SURROUNDED by members of his own kin, all arranged in rows on the fishmonger's slab, the Plaice is too familiar a sight to attract much attention, or to impress the passer-by as being an object of any special interest, apart from constituting a never-failing dish for the dinner or supper table. And yet this most familiar of all our British marketable marine fishes has quite a remarkable and romantic life-history. Let us try to follow it step by step.

In the English Channel and the North Sea the Plaice begin to spawn early in January, and continue to do so during the whole of February and March. Further north, spawning begins a little later, and is continued into April and even the beginning of May. The eggs are buoyant, floating near the surface of the sea, and are among the largest known floating eggs of fishes; they measure just under one-twelfth of an inch in diameter. The little germ within the egg develops slowly, and the egg is sufficiently transparent to permit one to watch with the aid of the microscope the gradual growth of the embryo. This development takes place when the temperature of the surface waters is low—somewhere in the region of 48° Fah. to 53° Fah.—the time varying



—The eggs of the Plaice are buoyant and float near the surface of the sea



2.—The Embryos can be seen within the semi-transparent eggs

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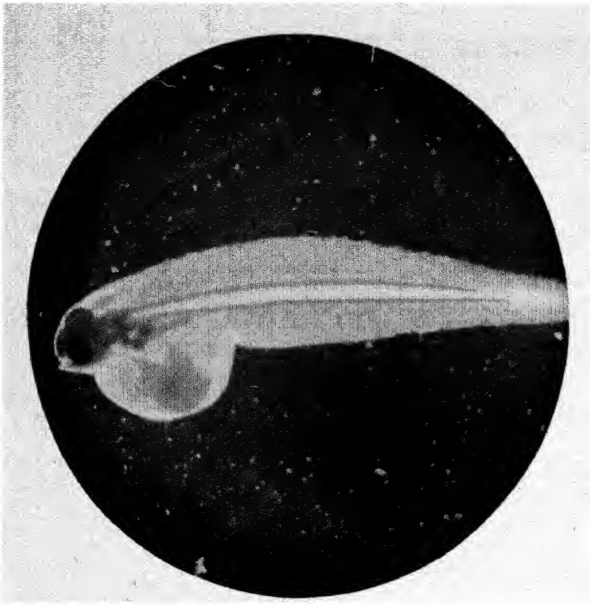


3.—A young Plaice just after escaping from the egg

4.—A little later; Yolk-sac nearly absorbed, and the mouth developing

with the temperature of the water. Cold retards development, so that it may occupy twenty-eight days in very cold weather, and be completed in ten to twelve days at 53° Fah.

When the baby Plaice hatches it is about one-fifth of an inch in length, and does not bear the slightest resemblance to its parents. Indeed, were its mother to meet it, she would not recognise her offspring; for instead of being flat and coloured on one side, and having both eyes on one side of the head, the newly-hatched baby Plaice has a round transparent body, and its large eyes are symmetrically placed, one on each side of the head, like the eyes of a cod or haddock. Just behind its chin is the large rounded yolk-sac, the contents of which has still to serve as the source of nourishment, for the little mouth is not yet sufficiently formed for taking in food. The tiny creature is by no means helpless, for it can wriggle and swim in the surface waters, and, as from day to day the contents of the yolk-sac is absorbed, begins to increase in size and to make a certain amount of progress towards shallower inshore waters. By the time the yolk is completely absorbed, the mouth of the fish is fully formed, and the baby Plaice begins to feed upon the floating spores of seaweeds, on microscopic plants called diatoms, and other equally minute forms of life floating in the surrounding waters.

As the little creature gradually grows and draws inshore towards shallower water, it quits the surface, and gradually sinks lower and lower, until at last it rests upon the floor of the sea. And now a

most wonderful series of changes begins to take place. Up to this point the baby Plaice has retained its round body and symmetrical head, but now it rests upon its left side, on the floor of the sea, and this is going to be its regular and natural position during the rest of its life. Obviously, in this position, the left-hand eye is no longer any good for visual purposes, and two eyes are very necessary for seeing one's way about and hunting for food. But this condition of things is not going to be permanent, and soon begins to change. First of all the little round body begins to show a very definite change of shape, it gradually flattens out as if pressure from some unseen force were exerted upon it, and there is a marked development of the dorsal and ventral fins. At the same time changes are taking place in the shape of the head, which is also flattened, and, wonder of wonders, the left-hand eye begins to shift its position, gradually moving, as can be seen in the photographs, round and over the top of the head, until at last it joins company with the right-hand eye; while the once symmetrical mouth also becomes pulled somewhat askew, until it attains a better position for the comfortable intake of food.

During these wonderful series of changes of shape, and migration of the left eye, the right-hand side of the body has become pigmented and darkened in hue, while the left-hand side, which rests on the floor of the sea, is pure white. The transformation is now complete, and the young Plaice, though scarcely half an inch long, has assumed the adult shape.

The Plaice, like many other marine fishes, has a chameleon-like power of changing colour, so as to harmonise with its surroundings, and thereby escape unwelcome observation. This change of colour, however, is confined to the right-hand side of the body, that is to say, the side which is always uppermost, and exposed to the light and to view. The left side, being turned away from the light, always remains pure white. If, however, a Plaice is kept in a glass-bottomed tank, and daylight is reflected by means of a mirror up through the bottom of the aquarium, then the left side will in time become pigmented; showing that light stimulus has a very important part to play in the variation and development of colour. It is curious to note that from time to time adult Plaice, Turbot, and other flat-fish are caught in which no migration of the eye has taken place, and that very often these abnormal individuals show pigmentation on both sides of the body. It would be extremely interesting if such a specimen could be safely transferred to an aquarium, where it could be kept alive and under observation for some time.

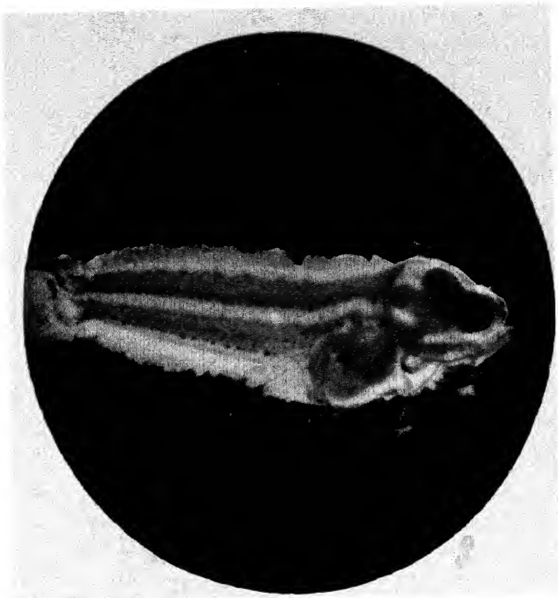
The Flat-Fish family (*Pleuronectidæ*), to which the Plaice belongs, is a large one. There are eighteen species common to the seas round the British Isles, all having the same peculiar and characteristic habit of lying upon one side, and having both eyes situated on that side of the head which is uppermost. But all the members of this important family do not rest upon the same side. As we have seen, the Plaice always lies upon its left

side, and has consequently both eyes on the right side of the head. This example is followed by the Flounder, the Witch, the Dab, the Rough Dab, Lemon Dab, Halibut, and all the Soles. On the other hand, the Turbot, Brill, Megrim, Scald-fish, and all the Topknots always rest upon their right side, and consequently have both eyes upon the left side of the head.

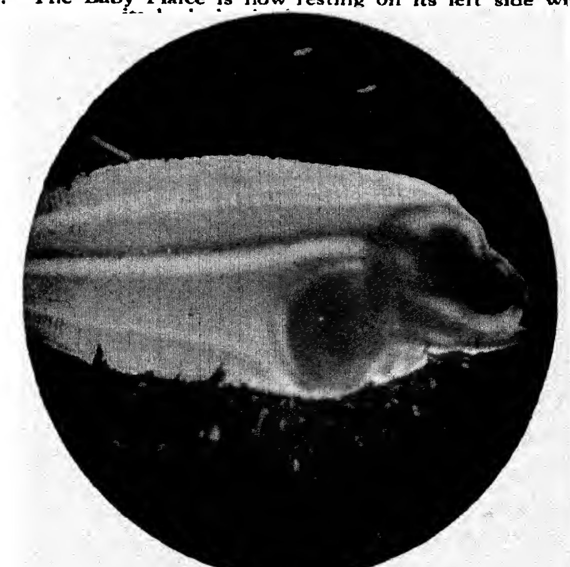
The geographical range of our friend the Plaice extends from the shores of Iceland to the Bay of Biscay; the finest specimens, veritable giants of the race, measuring twenty-eight to thirty-four inches in length, sturdy, dark-skinned, magnificent fellows, all come from the fishing grounds off Iceland; while the Plaice on the western fishing grounds of the English Channel, between Exmouth and Plymouth, average eighteen to twenty inches in length.

The Plaice is a prolific breeder, and it is estimated that a female measuring seventeen inches produces some 150,000 to 200,000 eggs during a single spawning season; a twenty-two inch fish producing from 450,000 to 500,000 in the same period. Obviously there are natural causes at work which prevent more than a small proportion of the eggs hatching, so that out of the millions of eggs and young produced annually, it is but a comparatively small percentage that ever reach maturity, all sufficient, however, to maintain the continuation of the species and the natural even balance of life in the sea.

But now an unnatural factor has come into play, one which I view with the greatest concern, for, if left unchecked, it may ultimately spell disaster to



5.—The Baby Plaice is now resting on its left side with



6.—Body and head are rapidly changing in shape while the mouth is fully developed for eating its food

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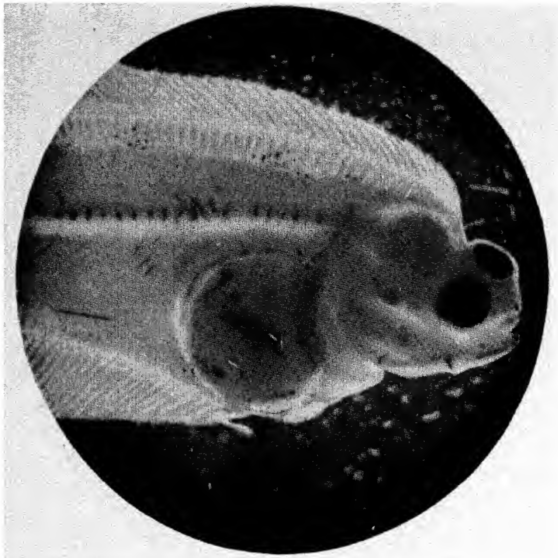
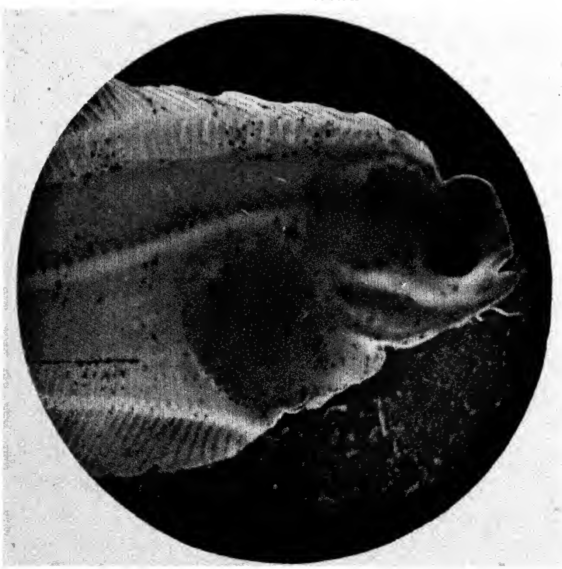


7.—The left-hand eye is coming over to the right-hand side of the head



8.—Left eye further advanced to right side of the head. Position of mouth undergoing change and pigment appearing on right side of body

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our great fishing industry and the serious depletion, if not destruction, of an important food supply. This factor is the waste oil from ships using oil-fuel, which at present is allowed to escape, or is pumped out with the bilge, into the sea. Oil-fuel is hardly out of its infancy so far as its use in ships is concerned, but its adoption is going to become more and more general every year, and the menace more formidable to deal with. Floating at the surface of the sea, this oil not only cuts off the life-giving rays of the sun, but poisons the surrounding waters, killing the buoyant floating eggs and those swarming microscopic forms of plant and animal life that form the primary food supply of all surface-feeding fishes; and when sinking to the floor of the sea chokes all forms of life upon which it settles. It is a menace of world-wide importance, and also a perfectly unnecessary waste of valuable material, for our marine engineers have already demonstrated that at a comparatively small cost efficient apparatus can be employed to separate and recover the oil from the bilge, and prevent its escape into the sea.

Although the Plaice spends its adult life on the floor of the sea, where it feeds upon various species of marine worms and bivalve molluscs, it is by no means a sedentary fish, and, indeed, makes considerable journeys. This has been demonstrated by means of the experiments which have been carried out in the North Sea in the marking of fish with specially designed metal labels. Perhaps to some of my readers it may seem rather startling to think that there is much chance of ever recapturing

a living fish that has had a label attached to it and then been returned to the sea; but, nevertheless, in pre-war days, out of 855 marked fish liberated in the North Sea no fewer than 21 per cent were recaptured within twelve months of their having been set free. And, as showing the movements of these fish, one that was caught, marked, and liberated on the Lemon Ground was recaptured three months later off Winchelsea, having covered in that time a distance of some 175 miles; while a second marked Plaice, liberated off Mablethorpe, was recaptured in St. Andrew's Bay, Scotland, having taken eight months to cover a journey over the floor of the sea of a good 210 miles.

Have you ever thought of trying to tell the age of a Plaice? I don't mean how long he has been out of the water, your nose is the best guide in that case, but what was his age last birthday? Well, there are two ways by which you may arrive at a very close guess. If you carefully open the head of a Plaice you will find two small, flat, oval shaped, stony objects, called the ear-stones or otoliths. Having cleaned these gently and placed them in a watch-glass filled with water, stand the glass on a black card and examine the little ear-stones through a pocket-lens. You will then see that they are made up of alternate bands of opaque and semi-transparent material. Now these regularly alternating bands represent seasonal growth, the semi-transparent bands being formed during the autumn and winter, and the denser opaque bands during the spring and summer. Therefore, by taking one opaque and one

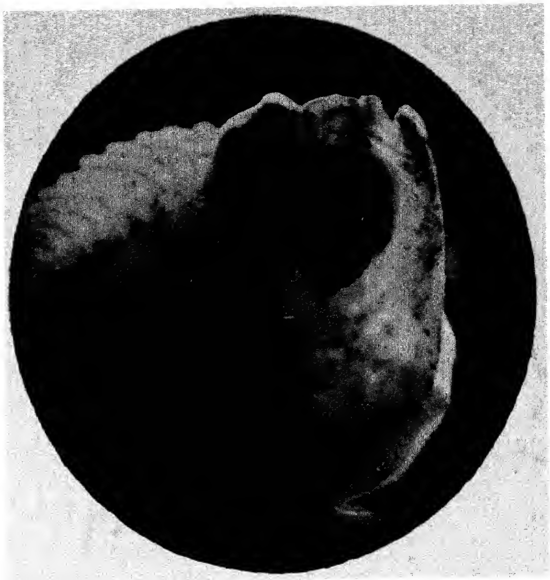
transparent ring as representing a year's growth, we can count up the total number of pairs, and determine the age of our fish.

If we take a clean undamaged scale from the body of a fish and examine it under the microscope, we shall see that its surface is composed of a regular meshwork, arranged in rings of alternating open and closely knit meshes. These, like the alternating bands of semi-transparent and opaque material of the ear-stones, represent seasonal growth, two of each kind to the year, and can be counted up in the same manner.

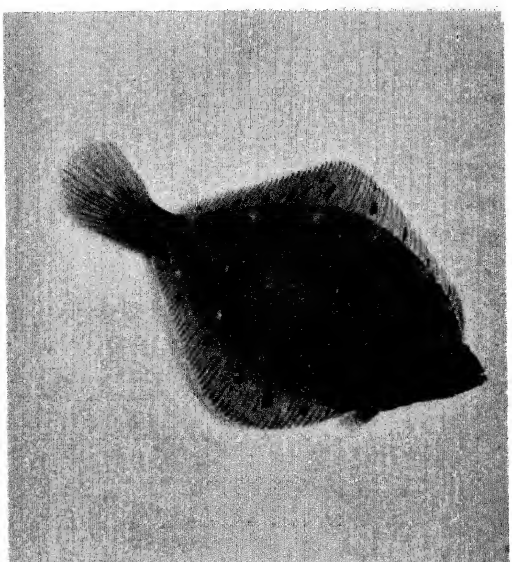
ON WHALES

ALTHOUGH all the members of the Whale tribe, or Cetacea, the Whales and Dolphins, externally present such a fish-like appearance, the essential features of their organisation show them to be true mammals. Thus, they breathe by lungs, have warm blood and a four-chambered heart, and give birth to living young which are suckled by the parent; while the great tail-fin, instead of being vertical, as in all fishes, is horizontal, and the skeleton of the fore-limb or flipper is quite different in its structure to that of any fish. Whales and Dolphins are, in fact, very highly specialised mammals, and their assumption of this fish-like form is one of the most striking examples of adaptation to their habit of life and surroundings. Their whole ancestry is not yet known, but it appears probable that they have descended from a hair-clad, land-dwelling mammal. All that remains of the hairy coat are a few bristles found in some species, when young, in the region of the mouth.

In many species the head is of great size, and externally appears to join on to the body without any distinct neck, while the body, from its junction with the head, gradually tapers away to the tail, which terminates in a large forked, horizontal



5.—Position of eyes and mouth in head of young Adult Plaice



6.—The Adult Plaice

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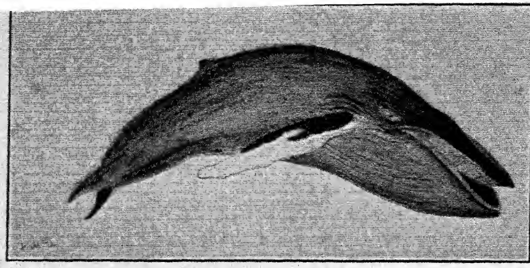
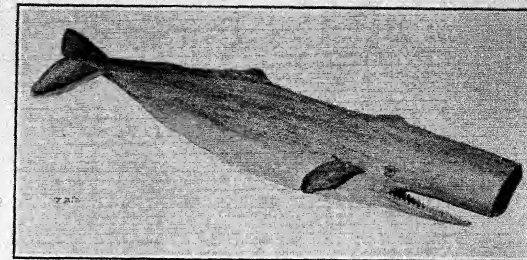
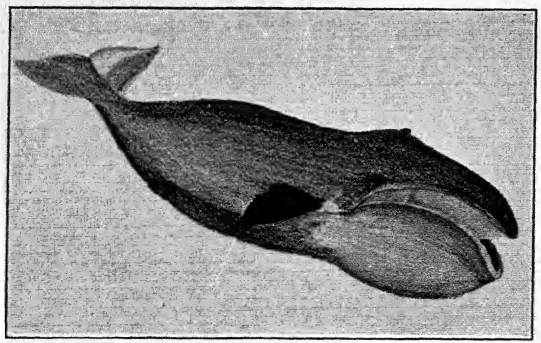


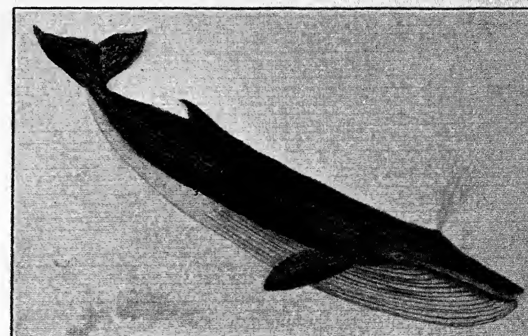
Humpback Whale



Sperm Whale



Bowhead, or Greenland Right, Whale



Finback Whale

expansion called the "fluke." Beneath the smooth and glistening hairless skin there is a thick layer of oily fat, the "blubber" as it is termed, the function of which is to prevent the absorption of heat of the body by the surrounding water. For such large beasts their eyes are remarkably small, while their ears have no external conch, but open by a very small aperture at a little distance behind the eye. The nostrils, which in some species have a single, while in others a double opening, are situated on the very summit of the head, so that they normally reach the surface of the water before any other part of the body, when the animal rises to respire. In connection with the nostrils and the act of respiration there still lingers a popular misconception as to what really takes place during the process of "spouting" or "blowing."

That Whales spout out from their blow-holes, or nostrils, water which has been taken in through the mouth is a very common and generally accepted misconception. Such an action is really impossible, for a Whale's nostrils do not open into the back of the mouth, nor is the Whale able to breathe through its mouth, as do ordinary land mammals. Instead of an opening into the back of the mouth, there is one continuous passage between the nostrils and the windpipe, and this special mechanism enables the Whale to swim with its mouth open under water and while feeding, without any fear or possibility of getting its lungs filled with water and thereby drowning. Moreover, this arrangement materially helps the Whale to hold its breath while below the

surface; and a Whale can hold its breath for a much longer period than any other mammal, remaining below the surface for an hour at a time without any apparent inconvenience.

When a Whale rises to the surface after a period of submergence, its first act is to discharge the air from its lungs with considerable force, and as this exhaust from the lungs is saturated with watery vapour at a high temperature, contact with the cold external air at once condenses it into visible vapour, which rises like a column of steam or spray to a considerable height above the surface of the sea. Sometimes a Whale will begin to "blow" before its nostrils are quite above the waves, in which case a certain amount of water will be forced up along with the jet of vapour, and it is this act which has led to the popular but erroneous idea that Whales spout forth fountains of water.

The bones forming the skeleton are of a remarkably loose and spongy texture, and, when the Whale is alive, are saturated with oil. One point of particular interest is the great modification of the bones of the neck, for, although the normal number of seven vertebræ are present, the body of each is so shortened that it has assumed the shape of a thin, broad plate; while in some species a certain number or even the whole of these plate-like vertebræ of the neck have become welded together into a solid mass.

The majority of species of Cetacea possess teeth, which are most frequently of a simple conical shape, and in many of the Dolphins are greater in number

than in any other mammals. In the "Whalebone" Whales, however, the teeth are replaced by large sheets of horny material, technically known as "baleen," which serve to strain the water from the small sea creatures upon which these great Whales feed. The baleen or whalebone does not make its appearance until after the birth of the Whale, and is composed of two long series of triangular flattened plates, placed transversely on each side of the palate, with their points hanging downwards. The inner edge of each plate is frayed out into a kind of fringe, and it is these fringes which act as strainers when the Whale is feeding. In the course of this process the huge cavernous mouth is filled with water, containing shoals of small sea creatures, chiefly crustacea and molluscs; the jaws are then closed and the tongue raised so as to diminish the size of the cavity of the mouth, and the water is forced out through the fringes of the whalebone or baleen, leaving the prey behind.

All the Cetacea prey upon living marine animals of various kinds; many feeding upon fish or small floating crustaceans, molluscs, jellyfish, and other invertebrate forms of life, while the principal food of some of the largest members of the tribe, such as the great Sperm Whale, consists of various species of cuttlefish of giant proportions. The Killer Whales alone eat other warm-blooded animals, preying upon seals, sea-lions, porpoises, and even the great Whalebone Whales.

In size the Cetacea vary greatly, some of the smaller Dolphins scarcely exceeding four feet in

length, while the largest Whales may measure eighty to ninety-five feet in length, and exceed in bulk any animal of either present or past ages. With few exceptions they are timid and inoffensive creatures, graceful and active in their movements, even the great Whales turning and twisting, diving and leaping clean out of the water with wonderful agility; while they are often most affectionate in disposition towards one another, the females displaying the greatest devotion and solicitude for their offspring. They are often social in habit, swimming in large herds or schools, which in days gone past numbered hundreds; but modern methods of whaling have sadly reduced these great "schools," until an early extinction now threatens them, unless something can be done to check the wholesale slaughter that has taken place during recent years. To quote only one example, it is officially estimated that no less than 4,285 Whales were captured during the ten years, 1898-1908, in the vicinity of Newfoundland alone, and this was by no means the largest "fishery."

Modern whaling has become a world-wide industry in the truest sense of the word, for to-day there are "fisheries" in the Antarctic islands of South Georgia, the South Shetlands, Falklands, South Orkneys, and Kerguelen, on the costs of Brazil, Argentina, Chile, Australia, and New Zealand, Tasmania, South Africa, Alaska, Japan, the Hebrides, Faroe Islands, and Greenland; so that literally in every sea, from the Arctic to the Antarctic, these great and most interesting animals are being hunted

down. No creature can long withstand such wholesale slaughter, and, therefore, it is not surprising that already ominous signs of an early and total collapse of the great whaling industry are causing grave anxiety. So serious is the position that the Government has recently sent out a special expedition on board the ship the *Discovery*, to carry out investigations into the whaling in South Georgia and the South Shetlands, and, in addition, a special marine station has been established at Grytviken, South Georgia, to further the work of the expedition. The *Discovery* carries a staff of trained zoologists whose investigations, it is hoped, will very materially add to our exact knowledge of these great mammals. Incidentally, the expedition will carry out important investigations concerning oceanography, meteorology and magnetism, work that should prove of much value in connection with the whaling and other fisheries, as well as adding greatly to our knowledge of animal life in the sea.

The existing Cetacea may be divided into two suborders, namely, the Whalebone Whales, which include the "Right" Whales of the industry, and in which the functional teeth are wanting, the upper jaw being supplied with sheets of "baleen" or whalebone; while in the second sub-order are grouped the Toothed Whales, in which teeth are always present, and to which the Killer Whales, the great Sperm Whale or Cachalot, and the Dolphins belong.

Strictly speaking, the term "Right" Whale is applied to those Whales which belong to the genus

Balæna, which are distinguished by the immense size of the head, the presence of whalebone or "baleen" in the mouth, the absence of a back fin, and of furrows in the skin of the throat. These Cetaceans have gained their popular name of "Right" Whales from the comparative ease with which they are caught, the fine flexible quality and great length of their whalebone and the enormous yield of oil obtained from their blubber. First of the Right Whales must rank the Greenland Bowhead or Arctic Whale (*Balæna mysticetus*), which attains a length of sixty-five feet. It is confined to Arctic seas, and is of massive size, its great head being out of all proportion, exceeding one-third of the total length of the animal. Its upper jaw is greatly arched to accommodate the whalebone, which is long, black, and very elastic, and in some individuals reaches a length of fourteen feet. The once important fishery of this Whale in the Greenland and Spitzbergen Seas is now practically extinct.

The second place among Right Whales may be said to belong to the Black Whales, which are distinguished by their relatively smaller head and shorter whalebone. These Whales inhabit the temperate seas of both the Northern and Southern Hemispheres, being found in the North and South Atlantic, and North and South Pacific; and, although divided into several species according to their geographical distribution, may probably be considered as merely local races of a single widely distributed species. The Northern Atlantic Right Whale (*Balæna glacialis*) may be taken as a typical

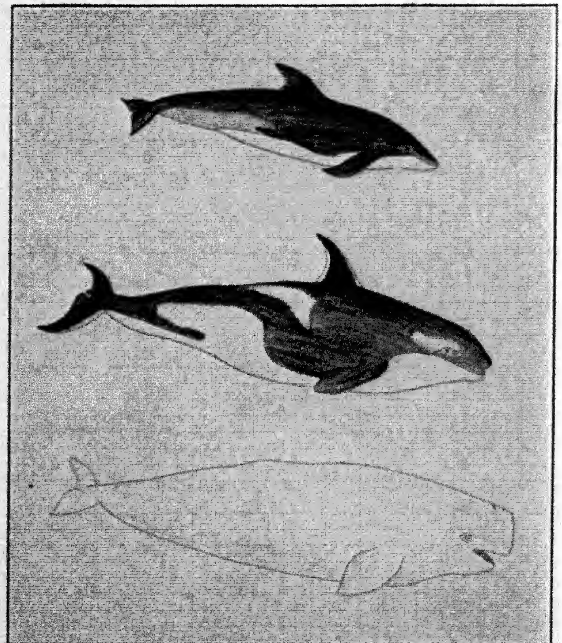
example. It is a massive creature, attaining a length of fifty-four or fifty-six feet, the great head being about one-fourth of the entire length of the animal, while the lower jaw is more highly arched, and the whalebone considerably shorter than in the Bowhead or Greenland Whale. This species was persistently hunted by the Basque fishermen of the Biscayan ports from the tenth to the sixteenth century, when the discovery of Spitzbergen in 1596 caused them to turn their attention to the more valuable Bowhead Whale.

Rorquals or Fin-Whales are distinguished from the Right Whales by the shorter and flatter head, their narrow flippers and long slender body, the presence of a fin on the back, and of deep parallel grooves or furrows in the skin of the neck. These characteristic furrows are a special mechanism to allow of the expansion of the region in which they are placed, so as to form a capacious pouch, capable of taking in a large bulk of water containing great quantities of small marine animals, such as fishes and crustaceans and molluscs. On contracting the pouch, the water is driven out through the meshes of the sieve formed by the whalebone, and the "catch" remains behind to be swallowed. It is only since the introduction of modern methods of whaling, and the use of explosive harpoons fired from guns, that the Rorquals or Finners, as they are popularly called, have been seriously hunted, for their great speed, the shortness of their whalebone, and comparatively limited amount of oil-producing blubber rendered them unprofitable under

the old method of whaling in which sailing ships and their boats were employed. Rorqual fisheries now exist in many parts of the world, and since 1905 the hunting of Rorquals, as well as Humpback Whales, has been carried on on a scale never previously deemed possible. Four species of Rorqual are known to inhabit the seas around the British Isles, namely, the Blue Whale, which is the largest of all known animals, and attains a length of 100 feet; the common Rorqual or Fin-Whale (*Balænoptera physalus*), which reaches from sixty-five to eighty-five feet in length when full grown; the Sei Whale, or Rudolphi's Rorqual, not much exceeding fifty feet in length; and the Lesser Rorqual, which rarely exceeds thirty feet in length. Rorquals are found in almost all seas, and these four species are believed to have an almost cosmopolitan range.

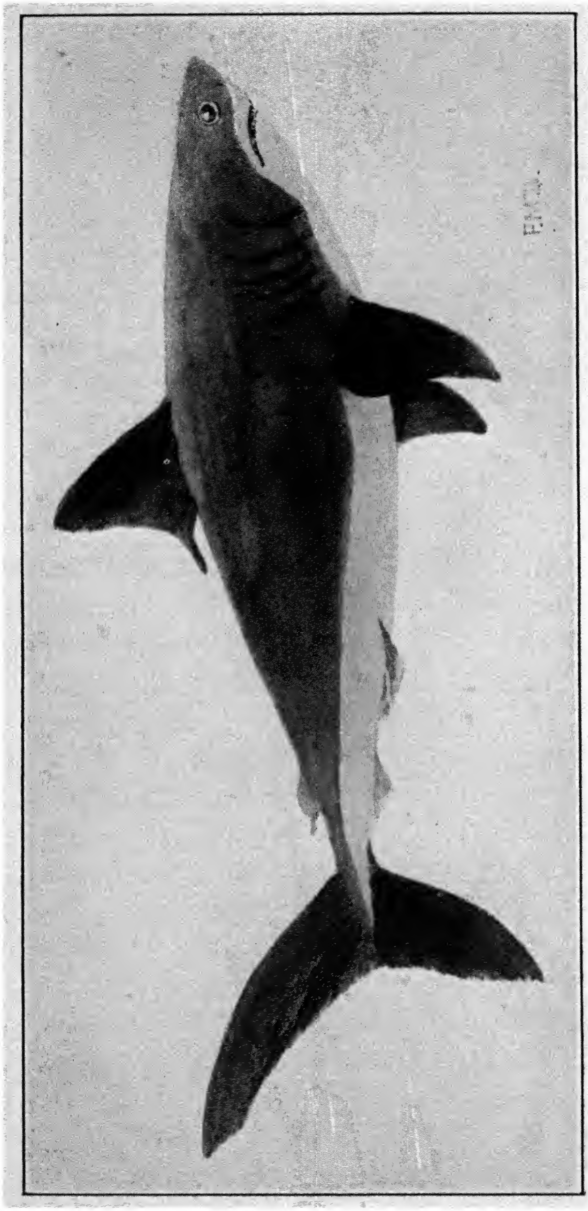
The Humpback Whale is nearly related to the Rorquals, from which it is readily distinguished by the shape of its body and the inordinate length of its flippers, which are often of a pure glistening white. The chin and throat are grooved, and form a dilatable pouch, as in the Rorquals, while the body is relatively short and thick, and the animal attains a total length of between forty-five and fifty feet. The Humpback Whale is widely distributed over the Atlantic, Pacific and Southern Oceans, but rarely visits the British seas.

All these Whalebone Whales are hunted, and although the Rorquals do not yield so much or so fine a quality of whalebone as the Right Whales,



Common Porpoise: Killer Whale: White Whale, or Belugia

Jaws of Great White, of Man-Eating, Shark



PORBEAGLE SHARK

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nevertheless, under modern methods of capture they are valuable for the oil and meat which they yield. Thus the Bowhead or Greenland Whale yields between sixty and seventy barrels of oil; the Blue Whale, fifty to sixty; the common Rorqual or Finner, thirty-five to forty barrels; the Sei or Rudolphi's Rorqual, five to ten barrels; and the Humpback twenty-five to thirty-five barrels. In Japan and the East the flesh of the Whale is recognised as wholesome meat, and finds a ready sale, both fresh and canned. Very little of a Whale is wasted nowadays in any of the fisheries, much of the flesh, skeleton and blood being converted into valuable guano or fertiliser.

Of the Toothed Whales, the Sperm Whale, or Cachalot, alone rivals in size the larger Whalebone Whale, and attains a length of seventy to eighty feet. The Sperm Whale is widely distributed, occurring usually in herds or schools, but whose numbers have sadly diminished of recent years. It frequents most warm seas, northward to the Shetlands and Iceland, while southward it ranges to the neighbourhood of the Antarctic.

The Sperm Whale is certainly one of the most remarkable of the many strange animals that dwell in the sea. Its great head, which occupies one-third of the entire body, is rectangular in shape, and contains an immense cavity, which is filled with the liquid oil known as "spermaceti." This natural reservoir is called the "case" by the whalers, and when cut open, the oil is simply baled out with a bucket; ten or fifteen barrels full being quite an

average yield. This spermaceti, which is liquid at the body temperature of the Whale, congeals slightly when cooled, and then presents an appearance resembling soft white paraffin. Formerly, it entered into the composition of the best white wax candles, and it is very valuable as a lubricant for the most delicate machinery. The lower jaw is short and slender, and armed with forty to fifty conical teeth, which fit into sockets in the upper jaw, and assist in holding the Whale's food, which consists chiefly of giant squids. These cuttlefish reach a length of twenty feet or more, and the Sperm Whale sometimes must have terrific battles with its huge prey, the tentacles of which, all armed with formidable clawed or serrated suckers, lacerate the skin and leave long gashes and scars on the head and mouth of the Whale. Teeth, in a very rudimentary condition, are present in the upper jaw, but they rarely protrude into the sockets, and have long ceased to be functional.

The substance known as ambergris is a concretion formed in the intestines of the Sperm Whale, and is due to a pathological condition of those organs, for it is stated, on good authority, never to be found in healthy, vigorous Sperms. Although the exact manner in which ambergris is formed is at present unknown, the fact that it often contains the horny beaks of cuttlefish leads one to suppose that it is in some way connected with the process of ejection of waste products from the digestive system. It may pass out of the animal with the excreta, and, as it is very light and buoyant, is found floating

on the surface of the sea in masses of large size; but occasionally Sperm Whales are killed whose intestines are entirely clogged with ambergris. It is a very valuable substance, and commands a high price, £4 to £6 an ounce being paid for it by the manufacturers of perfumes, who use it as a fixative in their scents; that is, to make the odour more lasting.

The Sperm Whale is a courageous and formidable monster, and will turn on its pursuers, using its tail with appalling effectiveness in delivering smashing blows and sweeping the surface of the water, and even crushing a luckless boat to matchwood between its powerful jaws.

The Bottlenose Whale is hunted for its oil and spermaceti. It is the commonest Cetacean found in British waters, the males measuring about thirty feet in length, a full grown specimen yielding about two tons of oil and two hundredweight of spermaceti. Gregarious in habit and usually travelling in herds of five or ten individuals, these whales display the greatest solicitude for a wounded comrade, and will rarely leave him until he is dead.

The White Whale, or Beluga, is pure white in colour when adult, and is one of the most important members of the Toothed Whales, for it is the animal which furnishes a very large proportion of the porpoise hide and porpoise oil of commerce. It is found in the North Atlantic and North Pacific, and is seldom found where the water is far above freezing point.

The Killer Whale, although of no great commercial value, is of interest on account of its habits. It has been aptly termed the wolf of the sea, and, like the land wolves, hunts in packs of twenty or more individuals, attacking and devouring almost anything that swims—fish, seals, sea-lions, walrus, whales, and porpoises are hunted down and devoured. Indeed, their rapacity is almost unbelievable. It is on record that no less than the remains of thirteen porpoises and fourteen seals have been taken from the stomach of a twenty-one-foot long Killer Whale. The Sperm Whale is probably the only marine animal capable of successfully combating a herd of Killers, and it is a significant fact that the flippers and flukes of the Sperm Whale rarely, if ever, show signs of having been injured, while those of the Rorquals and Humpbacks are frequently torn and badly mutilated.

The Dolphins and Porpoises represent the smaller members of the Cetacea; they associate in shoals or "schools," and display surprising grace and agility in their movements. Their food is chiefly fish and small cephalopods, and several species are not infrequently captured in herring and mackerel nets, while four living species of Dolphins inhabit respectively the rivers and estuaries of India, the Upper Amazon, the Rio de la Plata, and the Yang-tsi-kiang River.

Lastly, a brief reference must be made to the Narwhal, the Sea-Unicorn of the ancient authors, which is distinguished from all other Cetaceans by the peculiarity of its dentition, which, apart from

some vestigial teeth, is reduced to a single pair of upper tusks. These remain permanently concealed in the jaw in the case of the female, while in the male it is generally the left one alone which develops into a long and spirally-twisted tusk. In general form, the body of the Narwhal resembles that of the Beluga or White Whale, but the skin, instead of being pure white, is marked and spotted with various shades of grey.

It has been impossible within the limits of the present article to mention all the members of the Cetacea, and, therefore, the space at my disposal has been devoted solely to those species which are chiefly connected with the great whaling industry. It is hoped, however, that what has been included may have sufficed to help the reader to realise the interest and importance of those wondrous and unfortunately fast disappearing giants of the deep seas.

THE SHARK AND ITS KIN

THE Sharks and their relations are for the most part active predaceous fishes, living at different depths of the sea, from the surface to nearly a thousand fathoms, and ranging from mid-ocean to shallow waters round the coasts in almost every part of the world. They are most abundant in tropical and sub-tropical seas, where they attain their greatest size; and are numerous in temperate seas, while some are typical of the Arctic regions. Some of the Sharks are the largest of living fishes, and on account of their fierce predatory nature are veritable lions and wolves of the sea. All are carnivorous, but so diversified is their food that in different species we find it ranging from fishes of very substantial size to Molluscs, Crustaceans and quite minute invertebrate forms of ocean life. The Sharks and Rays may be distinguished from true fishes by their gristly skeleton, which is devoid of true bones, though sometimes strengthened by the addition of limy matter. They are also further distinguished by their separate external gill-openings, which, in the Sharks, are on the sides of the body; by their tooth-like body-scales, termed dermal denticals; and by the presence of a single nostril on each side of the head.

Formerly, all fishes were described as representing a single class of vertebrate animals, but the more searching investigations during recent years into their anatomy and general structure has tended to prove that really this motley assemblage of aquatic creatures should be divided into three distinct groups, each of which should rank as a class, and these classes are: (1) the Lampreys and Hag-fishes; (2) the Sharks, Dog-fishes, Rays, and Chimæras; and (3) the True Fishes, which includes the largest number of genera and species, and the bulk of our food-fishes.

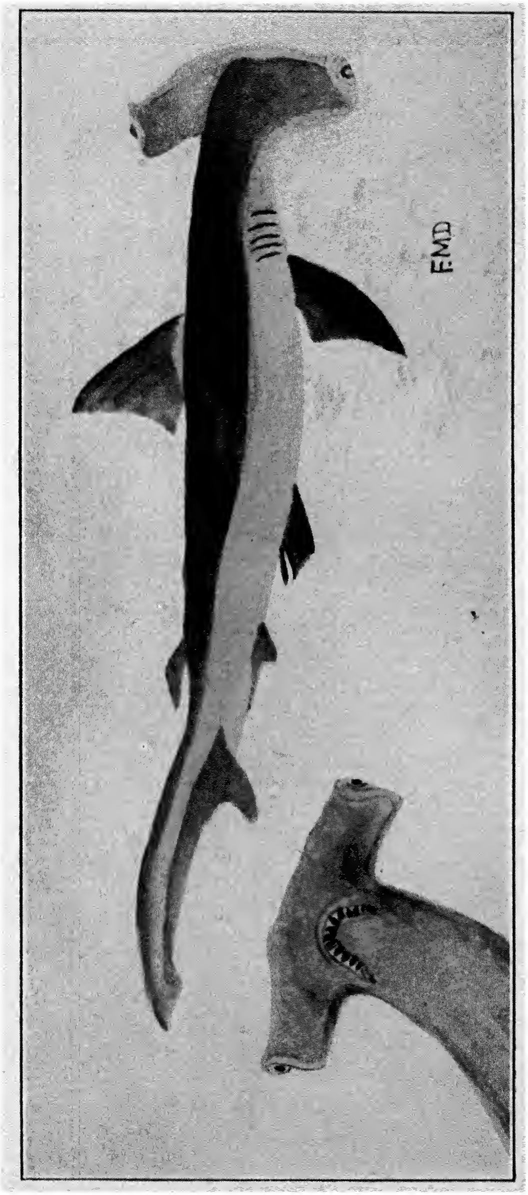
The Sharks and Rays are certainly of very ancient origin, and a primitive race of fishes. The fossil remains of their ancestors, in the shape of finspines and dermal denticles, are found in sedimentary rocks of very ancient formation, and are considered by geologists to rank amongst the earliest indications of vertebrate life; and in greater or less abundance their remains are found in the strata of every subsequent geological period; while they still survive in undiminished numbers and variety in the seas of the present day—certainly they must be counted as winners in Life's race.

When we look at a Shark or a Dog-fish, we at once realise that they are animals built for speed. The general shape of the Shark's body is like that of a torpedo, and the conical snout pushed forward over the jaws, really forms an efficient cut-water, greatly facilitating rapid progress when in pursuit of prey. A large number of the Sharks are viviparous; that is to say, they bring forth their young

alive; while certain species are oviparous, producing eggs which are nearly always enclosed in an oblong, more or less semi-transparent protective case, provided with horns or tendrils at each corner, by means of which the egg-case is attached to seaweed or rocks. After a heavy storm these cases, or "purses" as they are sometimes called, may often be picked up on the seashore.

There are two popular misconceptions with regard to these interesting fishes that still seem to be very generally believed by landsmen; one is that no real Sharks are found round our coasts except as very rare and extraordinary visitors; and the other, that all Sharks are dangerous to man. As a matter of fact, at least four species are regular visitors, and stray individuals of other species occasionally turn up along our coasts, while some of the largest known Sharks are quite harmless.

The most formidable of all existing Sharks is the gigantic White, or, Man-eater Shark (*Carcharodon rondeletii*), which is known to attain a length of fully forty feet, and is found swimming in the surface waters of all tropical and sub-tropical seas, from the Mediterranean to Australia and New Zealand. Its immense jaws are well furnished with large, triangular-shaped teeth, that have finely serrated edges. Its normal diet consists of fishes, but woe betide the bather, diver, or unfortunate shipwrecked sailor clinging to a spar, should one of these voracious tigers of the sea approach; while off the coast of California they take toll of the baby sea-lions. One caught not long ago in those waters was found to



Hammerhead Shark

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SAND SHARK AND SUCKER FISH

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have a recently devoured young sea-lion weighing about 100 lb. in its stomach. Nothing comes amiss to these hungry monsters, and every sailor who has voyaged in tropical seas knows how these great brutes will follow the ship for many days at a time, on the chance of devouring any refuse thrown overboard.

Sailors, not unnaturally, have an almost morbid loathing for the White Shark; and should one follow a ship persistently for several days it is looked upon as a bad omen. On one occasion, I well remember, when I was homeward bound from Tropical South America, we "picked up" a Shark off Rio which followed the ship for several days. I had been very ill with fever, and, as I rested in my long deck-chair, too weak and weary to take much notice of what was going on, only thankful to feel the gentle heave of the good ship as she nosed into the swell, I heard the steward and a deck-hand, who evidently thought I was asleep, gravely discussing whether Mr. Shark was after my body or that of an unfortunate Italian steerage passenger. They were both convinced that the Shark knew there were men aboard who might die, and was keeping a hungry, watchful eye for the funeral! The grim humour of the situation rather acted as a tonic, it appealed to the Scotch side of my ancestry, and, after giving them a piece of my mind, the interview closed to the accompaniment of suitable refreshments all round.

The Blue Shark (*Carcharias glaucus*) is another well-known species in tropical and sub-tropical

seas. It attains a length of fifteen to twenty feet, and its large crescent-shaped mouth is well furnished with sharp and formidable teeth. It is by no means an uncommon visitor to British waters, more especially on the southern coasts of Ireland, being found off our coasts mostly during the warmer months of the year, and at times causes serious damage to our fishermen's gear, when it preys upon the herrings and mackerel, tearing them out of the nets. This Shark gains its popular name from the deep blue colour of the back and upper half of its body. Fortunately, the specimens seen off our shores are rarely of sufficient size to be dangerous to man.

A Shark that is a pretty regular visitor in the summer and autumn to our western coast is the Porbeagle (*Lamna cornubica*), so called from its porpoise-like appearance and active predatory habits. Although not a very large Shark, at times it causes great damage to the fishermen's nets, and its ravages on the salmon in Alaska have earned it in those waters the name of Salmon Shark. It rarely exceeds ten feet in length, and its colour is a dull grey above and whitish beneath. The jaws are furnished with lancet-like teeth, apparently the better adapted for seizing and holding than for tearing its prey. The Porbeagle feeds on squids, hake, whiting and other fish, including its near relations the common and piked dogfish. It has a wide geographical range, being found in the Atlantic, Mediterranean and Pacific, and from all accounts is ready to put up a good fight for liberty when in danger of being

captured. That famous old Cornish naturalist, Couch, records an instance in which one, "in the prospect of being taken, sprang at a fisherman and tore a piece out of his clothing."

One of the commonest of the larger Sharks visiting our shores is the Thresher Shark (*Alopecias vulpes*), which is quite harmless to man, although it attains to a length of fifteen feet, of which the tail forms at least one half. As this Shark feeds on the shoals of pilchard, herring and mackerel, it is no friend of our fishermen, in whose nets medium-sized specimens are not infrequently captured. When feeding, this Shark swims in gradually diminishing circles round the shoal of fish, splashing the water with its long tail, and in this way keeping its victims crowded together so that they become an easy prey; and it is from this habit of beating the water with its large tail that the Shark has gained its popular name. The comparatively small size of the teeth of the Thresher clearly indicates that it is not adapted for killing large prey, and on that ground I am inclined to doubt the stories of this Shark having been seen attacking whales, leaping out of the water and belabouring the unhappy Cetaceans with powerful blows of its tail. I cannot help thinking that closer and more careful observation would have shown that it was the carnivorous Killer Whales and not the Thresher Sharks that were making the attack.

Certainly the most remarkable in appearance of all the Sharks recorded from British waters is the Hammer-headed Shark (*Zygæna malleus*). A rare

visitor to our shores, this Shark is unique among fishes in the extraordinary conformation of the head, the front part of which is broad, flattened and expanded on each side into a process bearing the eye, giving to the head its curious hammer-like appearance. The headquarters of these Sharks are the warmer tropical and sub-tropical seas, where they grow to a length of some fourteen or fifteen feet. The common Hammer-head is the most formidable and voracious of its tribe, and is greatly feared in the Indian seas, so it is just as well that the colder waters of our coasts are uncongenial to this fearsome monster.

The Basking Shark (*Selache maxima*) has gained its popular name from its habit of lying motionless on the surface of the sea in quiet weather, apparently literally basking in the sun's rays; and for the same reason it is often called the Sun-fish by the fishermen along the west coast of Ireland where, during the summer months, it is often seen in considerable numbers. Although a huge species, growing to thirty-five feet or more in length, the Basking Shark is quite harmless, for its large jaws are only provided with small rounded teeth, and its food consists solely of small marine animals, which are caught by the curious gill-rakers, elastic appendages attached to the large gill-openings, which really act like the blades of baleen in the mouth of the Whalebone Whale, as sifting organs, serving to filter the water passing through the gills, and retaining the small organisms. In the early summer, shoals of these Sharks pass along the west

coast of Ireland on their way from the southern to the northern seas, and at one time they were fairly extensively hunted, particularly off the Norwegian coasts, for the sake of the valuable oil obtained from their liver.

When a Shark has been caught on a line and is being hauled on board, a small fish may sometimes be seen attached to its under surface, which generally drops off as the shark is dragged clear of the water. This queer fish is popularly called a Sharksucker, and belongs to the genus *Echeneis*. There are several species of Suckers, and they vary in length from one to about three feet, and have a pretty wide geographical range. Not very strong swimmers, they attach themselves by a curious disc on the back of their head to some other fish, or to a turtle, whale or porpoise, or even the side of a ship, and by this means obtain ready transport, and in this way obtain more food than would otherwise be possible. They are common in the Mediterranean, and were known to the mariners of ancient Greece and Rome, who credited the Echeneis with the power of retarding, if not actually stopping, the progress of a ship through the sea. How this curious idea originated it is impossible to say, but that it was very general is obvious from the frequent references found in ancient works on natural history. Nor do we know much about this queer association between the hungry Shark and his outside passenger. In the fine aquarium at New York, Sand-sharks may be seen swimming about in their large tank, with one or more Sucker-fish attached,

and a perfectly friendly relationship appears to exist. Probably, under natural conditions, the Sucker not only derives the benefit of free transport, but also scraps from the Shark's banquet.

The numerous species of Dog-fish are all close relations of the Sharks, and some of them reach a large size and are formidable creatures at close quarters. The common Dog-fish or Husse, as it is often called by the Sussex fishermen, is uncommonly good eating when filleted and fried. One species in particular is cordially detested by the fishermen, on account of the damage caused to their nets, and its habit of stealing bait, and that is the Spiny or Piked Dog-fish. Moreover, the spines on its dorsal fin are capable of inflicting very dangerous wounds.

The curious Angel-fish or Monk-fish (*Rhina squatina*), so far as external shape is concerned, forms a connecting link between the Sharks and the Rays. The name Angel-fish is derived from the shape of the pectoral fins, resembling wings; that of the Monk-fish from a fancied appearance of a cowl on its head; while from its general shape it is also sometimes called a Fiddle-fish. It arrives off our coasts from the deep sea during the spring months, and is said to be particularly partial to plaice and other flat fish. It grows to six or ten feet in length, and is capable of inflicting a severe bite if incautiously handled.

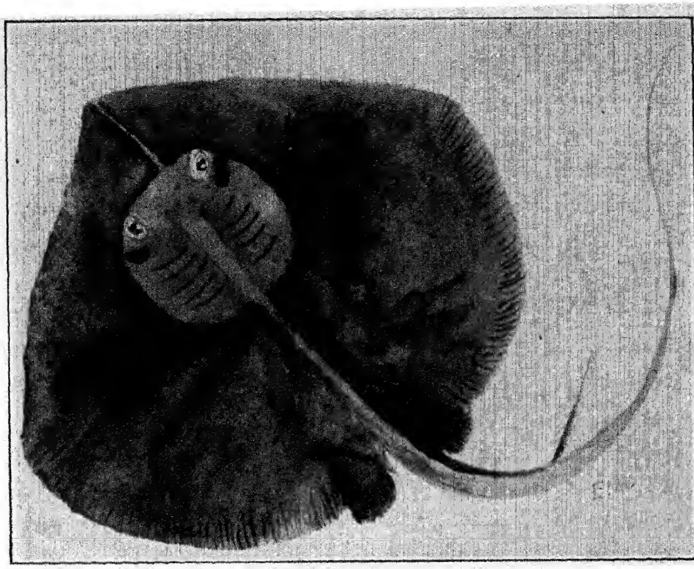
The Saw-fishes are near relations of the Sharks. They have a rather flattened body, elongated and somewhat shark-like, while the snout is produced

into a long, flat blade, armed down each side with large teeth set in sockets. The teeth in the jaws, however, are minute and blunt, and quite useless for inflicting wounds or seizing prey. It is by powerful side to side movements of the saw that the Sawfish kills its smaller prey; while, when attacking a large victim, it is said to use the saw to tear off lumps of flesh from the body of its prey, which are then swallowed. Some species attain an immense size, individuals upward of twenty feet in length being not infrequently met with in tropical and subtropical seas.

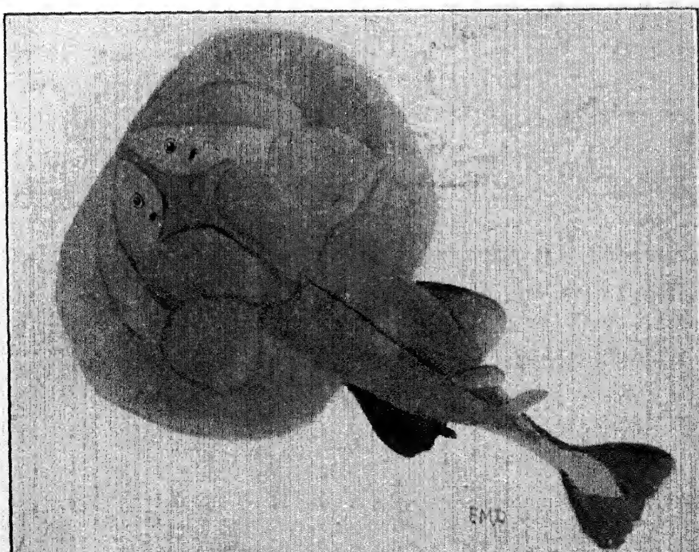
Of the great family of Rays I have only space to mention one or two of the most remarkable forms. They are distinguished from the Sharks by their flat more or less triangular shape, by the position of the gill-openings, which are always on the under-surface of the body, and in having the pectoral fins more or less joined to the sides of the body and head. They represent a specialised offshoot from the Sharks, and the majority of them, having taken to living on the sea-bottom, have become specially adapted to that mode of life. The first family comprises the remarkable Electric or Torpedo Rays, which are able to benumb their enemies by means of powerful electric shocks, produced from elaborate electric organs, which take the form of a pair of large oval masses of tissue lying just below the skin. The exact manner in which the electric current is produced is not yet known, but it seems probable that the nervous components of the organ perform the chief part in the process. These Electric Rays

appear to be sluggish fish, concealing themselves in the sand or mud, where they lie in wait for their prey. The Common Torpedo is often taken by fishermen off our coasts, and the men frequently receive severe shocks from merely touching the fish. A five-pound salmon taken from the stomach of one had no mark or blemish on its body, and evidently had been killed by the electric current. The Torpedo Ray was well known to the ancient writers, and was described by Pliny, while Dioscorides recommended its external application as a cure for violent pains in the head. In the days of Galen its flesh was recommended as a diet for epileptics, who were also to have shocks from applications of the living Torpedo to their heads. Persons suffering from gout were also advised to place the affected foot on a live Torpedo, and to keep it there until the numbness extended to the knee—a primitive mediæval electric treatment. Truly, there is little that is new even in the realm of medicine.

The Sting or Whip-tailed Rays are chiefly inhabitants of the warmer seas, though the common Sting Ray (*Trygon pastinaca*) is often taken off our coasts. Its tail is armed with a strong, sharp-pointed spine, the so-called sting, which has serrated edges, and is capable of inflicting a very painful, sometimes dangerous wound. In the old Greek mythology, we have handed down to us the story of how Circe armed her son with a spear, which she pointed with a Trygon's spine, as the most formidable weapon she could place in his hands,



A GIANT STING RAY



THE TORPEDO RAY

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and with which he subsequently unintentionally slew his father, Ulysses.

The size of the tail spine or "sting" varies in different species, and in the larger forms may be a good fifteen inches in length. It is a powerful weapon, capable of inflicting very severe wounds, which take months to heal, and sometimes even occasions the loss of a limb. The sting-spines are shed from time to time and replaced by others growing from behind.

The uncanny appearance of these great Rays naturally attracted the notice of the mediæval authors and artists, with their love for the weird and grotesque.

Some of the Eagle Rays attain an enormous size, and are among the largest of fishes. The Devil-fish (*Ceratoptera vampyrus*) of the West Indies, for example, grows to a width of twenty feet, and is said to attain a weight of more than a thousand pounds. It is much dreaded by the divers engaged in the pearl fisheries near Panama, who firmly believe that it will devour them after enveloping and crushing them in its vast fins; but from the form of the mouth and the teeth, which are large and flat, and arranged like stones in a pavement, it is somewhat doubtful whether the Devil-fish would devour anything much larger than the pearl oysters themselves. The head of this Ray, and of several closely related species, presents a curious appearance, due to the so-called cephalic fins in front of the snout, that look something like a pair of horns, and from which the fish is sometimes called a Horned- or Ox-Ray.

Lastly, a word about that strange cousin of the Shark, the Chimæra, or King of the Herrings. Its scientific name, *Chimæra monstrosa*, graphically describes the weird uncanny appearance of this remarkable fish, about whose habits we still know comparatively little, while its popular name relates to the fact that it is not infrequently taken among the herring shoals on which it is said to feed. The Chimæra attains to three or four feet in length, and has a large head, which, in the male, is surmounted by a curious club-shaped appendage, known as the frontal clasper, armed with a pad of recurved denticles. Nothing very definite is known about the mating habits of this queer fish, but it seems probable that breeding takes place in deep water, as most of the specimens of its peculiar styliform egg-cases have been dredged up from depths of two to three hundred fathoms. The Chimæra has a wide geographical range, having been recorded from the Arctic, the northern and temperate sea-board of Europe, the Mediterranean, Azores, Cape of Good Hope, Pacific coast of North America and Japan.

THE STARFISH AND ITS KIN

LEFT stranded on the shore by a receding wave, the common Starfish looks particularly helpless and flabby, not at all the sort of creature one would suspect of being a greedy rascal, or the most cordially detested foe of every fisherman. But then we have come upon him at a moment when he is very literally out of his element; a condition of things which has probably been brought about by his having crawled, while the tide was up, too far inshore in search of food, and, absorbed in gastronomic pleasures, or overcome by the lethargy of repletion, has dallied until it was too late to beat a safe retreat with the turn of the tide.

To look at him under such conditions it is hard to believe that the Starfish is capable of strong and active movement, or that he can extract oysters and mussels from their tightly closed shells. Nevertheless, our stranded Starfish is really a very remarkable and interesting animal, with quite a romantic sort of life-history, and many curious relations.

As a matter of fact, our Starfish started life as a tiny semi-transparent, somewhat cone-shaped little creature, almost too small to be clearly seen without the aid of a magnifying glass, and more or less

covered with bands of delicate lashers or cilia, by means of which it swam freely about in the surface waters of the sea. But this free-swimming period does not last very long, and then the little creature sinks down to the floor of the sea and takes on its adult form. From the round, plump body-disc the five arms or rays spread out, each gradually tapering to a blunt point. The skin which covers the body and rays is soft and semi-transparent, so that we can see beneath it the curious meshwork of rods and plates that go to make up the skeleton; while rather to one side of the body-disc, and about half-way between two of the rays, can be seen a small round button-shaped object covered with a delicate tracery of fine grooves which is called the "water-pore," or, from a fancied resemblance to a brain-stone coral, the "madreporite." This water-pore acts as a kind of filter, through which the Starfish constantly draws in a fresh supply of water to fill a complicated series of tubes within its body, extending to each ray.

So much for the upper surface. Now let us turn the Starfish over on its back in a pool of water and see what we can make out. In the centre of the body there is an opening into which it is quite easy to push the tip of your little finger, which is the animal's mouth. It is a very elastic one, capable of quite remarkable stretching, and leads directly into a capacious, bag-like stomach that fills the centre of the Starfish's body, and also projects a little way up into each ray. From the region of the mouth a furrow, or groove, runs down the entire

length of each ray, and is lined with little tubes which, in our living specimen, are seen to be all on the move, twisting and turning, elongating and contracting, bending in all directions in their efforts to grasp some object and enable their owner to turn himself right-side up once more. It is by the aid of these countless tube-feet, that the Starfish is not only able to crawl rapidly over the floor of the sea, but to seize and hold his prey.

Now the Starfish has a voracious appetite, and nothing seems to come amiss to him, so that to a certain extent he may be regarded as a natural scavenger, but, unfortunately, he has a great liking for prime native oysters, and, consequently, when large numbers of Starfish invade the oyster beds, very serious loss may ensue. It seems rather remarkable to think that this soft-bodied, rather helpless-looking creature can extract an oyster from its shell, when we require a special kind of knife and some force to accomplish it.

When the Starfish wants to devour an oyster, he simply settles down on top of it and folds his arms or rays over his victim, so that he looks rather like a half-closed umbrella, and has the edges of the oyster's shells pressed against his mouth. Now using his innumerable tube-feet, the Starfish grasps the upper and under shells of the oyster and begins to pull steadily. At the first warning of the all-embracing grasp of its foe, the oyster shuts its valves tightly together, and strains every muscle to prevent their being torn asunder. But the fight is an unequal one, for, although the oyster can

withstand a sudden pull of considerable force, far beyond the capabilities of its foe, the Starfish has great staying powers, and can keep up a steady pull for several hours if necessary, without the least sign of fatigue. In this unequal duel, however, it is probable that the oyster is not entirely overcome by the dragging powers of the Starfish, but that it becomes affected by secretions poured forth from the mouth of its foe—while the Starfish will actually protrude the edges of its bag-like stomach through its mouth, and apply them to the edges of the shell of its victim. Should the Starfish seize upon a half-grown oyster or mussel, it will not bother to drag the valves apart, but simply proceed to stretch its mouth over the luckless mollusc, swallowing its victim, shell and all, the empty shell being later on ejected by the same route.

The Starfish, like so many creatures that live in the sea, has a wonderful power of replacing lost limbs, and in his native element is extraordinarily tenacious of life. Therefore, it is a bad policy when a large fat fellow comes up on the end of your line, having comfortably swallowed the bait, to vent your ire by chopping him in two and throwing the remains back into the sea; for the chances are quite in favour of those two halves each growing a new complement of arms, and thus becoming a complete Starfish!

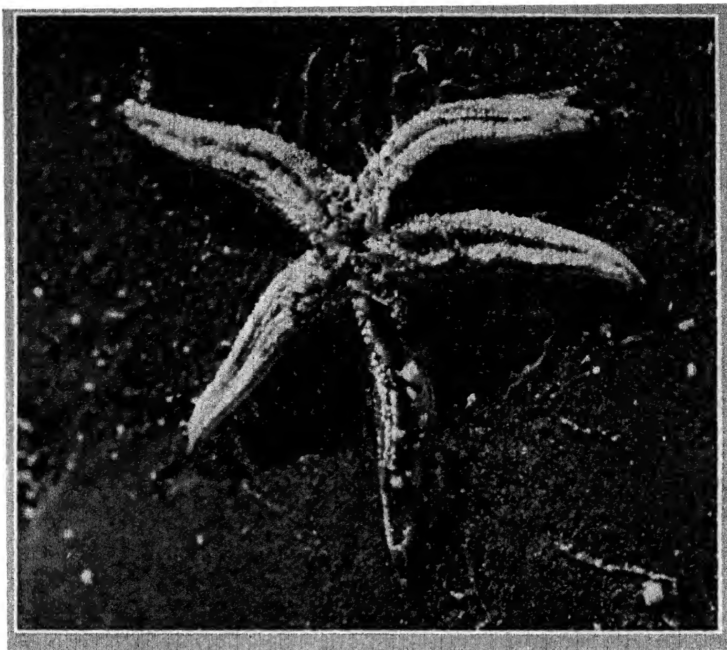
Sprinkled over both the upper and the under surface of the body and rays of the Starfish are a very large number of quite remarkable appendages, microscopic in size, whose function it is to keep

the surface of the body clean. These *pedicellariæ*, as they are called, have the form of minute pincers, consisting of two blades articulated to a basal stalk. When touched by any minute object these miniature pincers open their tiny blades and then snap them smartly together, retaining a firm grasp upon the object they have seized for a considerable length of time. These *pedicellariæ* are a very characteristic feature of the group of animals to which the Starfish and its relations belong, and in some species are developed into very complex and even poisonous weapons, used for the capture of prey, and probably for defensive purposes.

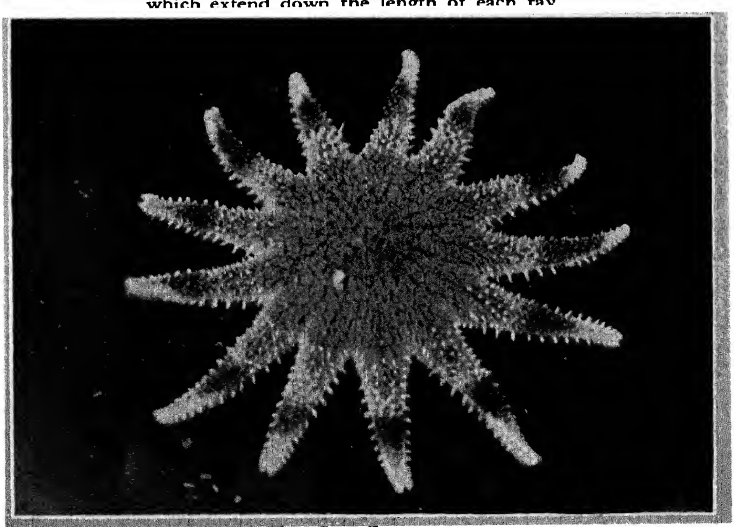
The Starfish and its kin form that division of the animal kingdom known to Science as the *Echinodermata*, a term derived from two Greek words, and which, literally translated, means spiny-skinned animals. Although all the animals included in this group have not got their bodies covered with spines, most of them have curious calcareous plates or ossicles embedded in the skin. All are dwellers in the sea, and while some bury themselves to a depth of several inches in the sand or mud, others live in crannies in the rocks, or crawl about on the floor of the ocean. They have a world-wide distribution, from the cold regions of the Arctic and the Antarctic to the Equator, and many curious forms have been dredged up from great depths.

Many interesting Starfishes are to be found round our coasts, some frequenting the wide sandy bays, others loving the deep rock-pools, or living in deeper water, and large numbers are brought up

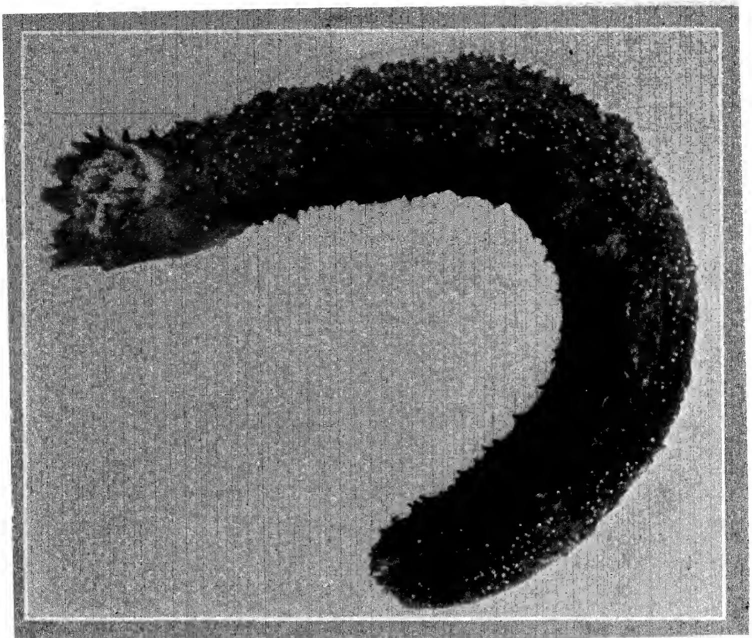
by the fishermen in their trawls. Among the latter may be included the handsome, many-rayed sun Starfishes and the fat, stumpy-rayed cushion Stars. Occasionally the trawl brings up a specimen of the Lingthorn (*Luidia fragillisima*), a handsome, large Starfish with five to seven long, flat, and rather slender rays. It is, however, a most difficult creature to preserve whole, and the late Professor Forbes has left the following amusing account of his fruitless efforts to obtain a perfect specimen for his collection: "The first time I ever took one of these creatures I succeeded in getting it into the boat whole. Never having seen one before, and quite unconscious of its suicidal powers, I spread it out on a rowing bench, the better to admire its form and colours. In attempting to remove it for preservation, to my horror and disappointment I found only an assemblage of rejected members. My conservative endeavours were all neutralised by its destructive exertions, and it is now badly represented in my cabinet by an armless disc and a discless arm! Next time I went to dredge on the same spot, determined not to be cheated out of a specimen in such a way a second time, I brought with me a bucket of cold fresh water, to which Starfishes have a great antipathy. As I expected, a *Luidia* came up in the dredge—a most gorgeous specimen. As it does not generally break up before it is raised above the surface of the sea, cautiously and anxiously I sank my bucket to a level with the dredge's mouth, and proceeded in the most gentle manner to introduce *Luidia* to the purer element.



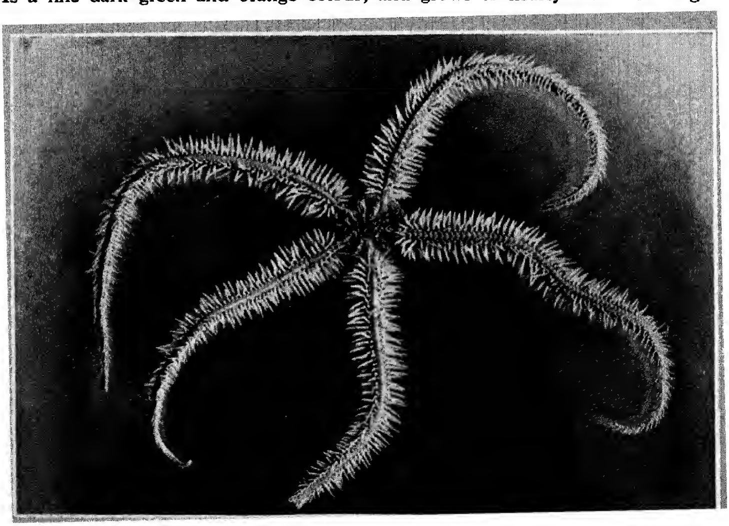
THE MOUTH OF THE STARFISH
Is seen here in the centre of the body-disc, and is surrounded by tube-feet which extend down the length of each ray



THE SUN STARFISH
Has many arms, and is often brilliantly coloured



THE SO-CALLED SEA CUCUMBER
Is a fine dark green and orange colour, and grows to nearly a foot in length



THE SPINES ON THE RAYS OF THE BRITTLE STARFISH STAND OUT AT RIGHT-ANGLES

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Whether the cold air was too much for him, or the sight of the bucket too terrific, I know not, but in a moment he proceeded to dissolve his corporation, and at every mesh of the dredge his fragments were seen escaping. In despair I grasped at the largest, and brought up the extremity of an arm with its terminating eye, the spinous eyelid of which opened and closed with something exceedingly like a wink of derision."

The sand and brittle Starfishes are all creatures with small disc-like bodies and long, slender rays or arms. The greater part of each ray is formed by a central bony axis, which is composed of successive joints, and fills up almost the whole of the internal cavity—there being no longitudinal groove filled with tube-feet as in the rays of the ordinary Starfishes. The spines on the rays of most of the brittle stars stand out more or less at right angles, giving a curiously prickly appearance to the long, slender, snaky arms as they twist and turn; while in the sand stars they are shorter, and curved towards the sides of the rays, like scales, giving the small tapering rays rather the appearance of tiny lizard's tails. Probably the most remarkable of all this class of Starfishes are the Shetland Argus (*Astrophyton*) and the closely allied Gorgon's head (*Gorgonocephalus*), in which the slender arms are repeatedly forked, so that a regular crown of interlacing branches is formed.

The Sea-urchins form the third class or division of this interesting group of marine creatures. They are all more or less globular or disc-shaped animals,

possessing a skeleton forming a complete cuirass of plates of hard carbonate of lime, except for a space round the mouth, and another at the anal surface of the body. The spines, which more or less cover the body of the Sea-urchin, vary considerably in length and thickness in the different species; they are disposed in five broad zones around the body, and are attached to rounded knobs on the cuirass of plates by cylindrical bundles of muscles which enable the spines to be moved in all directions. Alternating with the five broad zones are five narrow ones, on which the spines are not so plentiful; and these narrow zones of the cuirass are pierced with small holes, through which the long and slender tube-feet of the Sea-urchin are extended. It is by the combined movement of the spines and the tube-feet that the Sea-urchin is able to creep about over the floor of the sea.

It is in the sea-urchins that we find those curious organs, the *pedicellariæ*, most highly developed, no less than four kinds being present on the body of the common Sea-urchin (*Echinus esculentus*), and each type having its special function, either as cleansing organs for the removal of particles of foreign matter that may fall upon the urchin's body, or as weapons for the capture and paralysing of prey. The mouth of the animal is situated on the under surface of the body, and is furnished with a very complicated masticating apparatus and five longish, sharp-pointed teeth, the whole mechanism forming a five-sided conical mass rather like a miniature oriental lantern in shape, called the lantern of Aristotle,

after the famous old philosopher, to whom we owe the first accurate description of these interesting creatures.

The different species of Sea-urchins vary very considerably both in shape and size, while many are gaily tinted. The Common Sea-urchin (*Echinus esculentus*) attains the size of a big grape-fruit or Jaffa orange, and is slightly flattened on its under surface. This Sea-urchin is fairly common off-shore round our coasts, and all along the shores of the Mediterranean, where it is caught and used as an article of food. On wide, sandy shores, we may often pick up the test or shell of the curious heart-urchin, which, when alive, burrows in the sand to a depth of some eight or ten inches, and keeps up communication with the surface by a narrow, somewhat cylindrical hole. The Cake-urchins also love the shallow seas, and live half buried in the sand. They have gained their popular name from their flattened, more or less oval form, and have small tube-feet, by means of which they crawl about over the floor of the sea when the tide is up. As the tide begins to ebb, they disappear below the surface of the sand.

At the first glance, it is a little difficult to believe that those long, sausage-shaped things that the fishermen call Sea-cucumbers, or Sea-girkins, are relations of the Starfish and the Sea-urchins; but such is the case, in fact they form the fourth class of this great group. They are all creatures possessing more or less rounded, elongated bodies, having round the mouth a fringe of branched tentacles

The body is enclosed in a tough skin, in which are embedded numerous spicules and plates, very minute in size, but often of great beauty; some looking like tiny anchors, St. Andrew's crosses, or oval plates with rose pattern perforations. There is a slender worm-like species that lives in the sand round our coasts, called the *Synapta*, which has the most beautiful plates and anchors embedded in its skin. Certain tropical forms, which abound in the Pacific and China Sea, grow to over a foot in length, and are used as food; their capture and curing forming quite an important native industry. They are caught and partly sun-dried, partly smoke-cured, and are sold in China and the East under the name of *Trepang* or *Bêche de Mer*, being considered a great delicacy.

SOME MARINE BORING ANIMALS

IN the years 1730–32 much of the coast of Holland was threatened with destruction, and the country behind with devastating inundations, owing to the wooden piles that supported the dikes and sea-walls having become in a ruinous condition as a result of the ravages of the Ship-worm (*Teredo navalis*). So great was the damage and the threatened danger to life and property, that enormous sums of money, running into hundreds of thousands of pounds, had to be expended ere the possibility of sudden inundation was averted. Indeed, when we come to dip into the records of the past, we find that the Ship-worm must rank as the most ancient foe with whom "those who go down to the sea in ships," or whose business it has been to build wharfs and piers, have had to contend. Well might the great Linnæus in his writings term it "calamitas navium." However, a useful lesson was to be learned, even from the ways of the dreaded Ship-worm, for that great engineer, the elder Brunel, is said to have declared that the method adopted in the construction of the Thames Tunnel was suggested to him by examining the burrows of the Ship-worm.

Naturally, so notorious a creature has attracted a great deal of interest, and the patient investigations

of many able marine zoologists has resulted in a wider and more accurate knowledge of its life-history, habits and geographical distribution. Now the Ship-worm is not a worm at all, but is really a cousin of the cockles, mussels and oysters; that is to say, it belongs to the great order of the Mollusca in which all true shell-bearing animals are grouped, that particular division the members of which are the proud possessors of a double shell, an upper and a lower valve, and of which the oyster, scallop and cockle are familiar examples.

But the Ship-worm is a highly specialised creature, and for countless generations, aye, even in the long geological past, has burrowed into floating and submerged timbers. Consequently, it has undergone many modifications of form, the better to adapt it for its mode of life. Thus, the two valves of the shell, which in the oyster are large and completely enclose the animal, are, in the Ship-worm, reduced to a pair of small plates situated at the head end of the creatures' long, soft, worm-like body. At its other end the body gradually tapers, and terminates in a fine pair of extensible tubes of unequal length. Through these two tubes, or siphons, as they are called, the water required for respiration is drawn and expelled. They connect up with two tubular passages, which run inside the whole length of the body of the Ship-worm, and are separated by a partition formed by the gills. By means of the fine vibratile hairs or "cilia" with which the gills are covered, a constant current of water is kept flowing from one of the passages to the other. Exter-

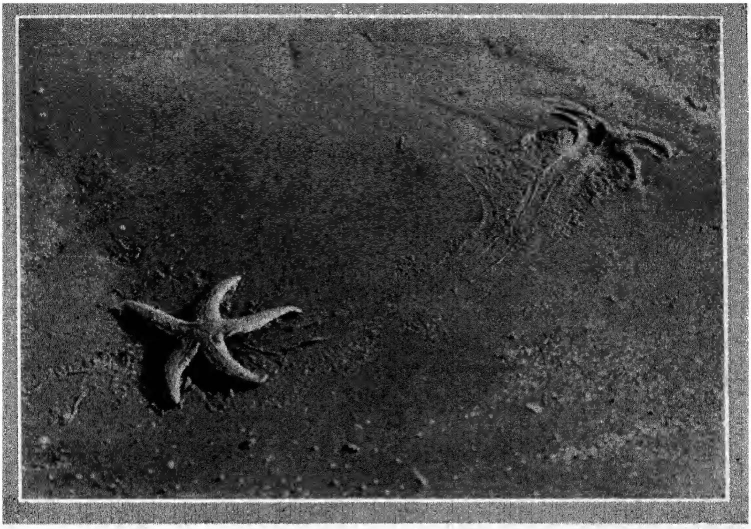
nally, at the base of the siphon tubes, are a pair of small shelly plates, called the pallets, whose duty it is to block the entrance to the burrow when the siphons are withdrawn. These little pallets vary in size and shape in the different species of Ship-worms: in the common *Teredo* they resemble a pair of rackets, while in an allied genus called *Xylotra*, they consist of a series of segments and a long stalk, and look rather like a pair of small quill feathers sticking out from the entrance to the burrow.

The tools, which the Ship-worm uses so effectually in excavating its burrow, are the valves of the shell. These are of somewhat complicated form, having a deep right-angled notch on the front edge, as if a portion of the shell had been broken away. If the valves are carefully examined, it will be seen that their outer surfaces, parallel to this notch, are engraved with a series of fine ridges and grooves; while under a strong magnifying glass or a microscope, it will be seen that the ridges are really rows of fine sharp-pointed teeth, the whole series forming an admirable file or rasp. During the whole life of the Ship-worm, as the shell grows, new rows of teeth are continually being added along the edges of the curious notch, so that the latest formed, and therefore the sharpest teeth, are in the best position for rasping against the end of the burrow.

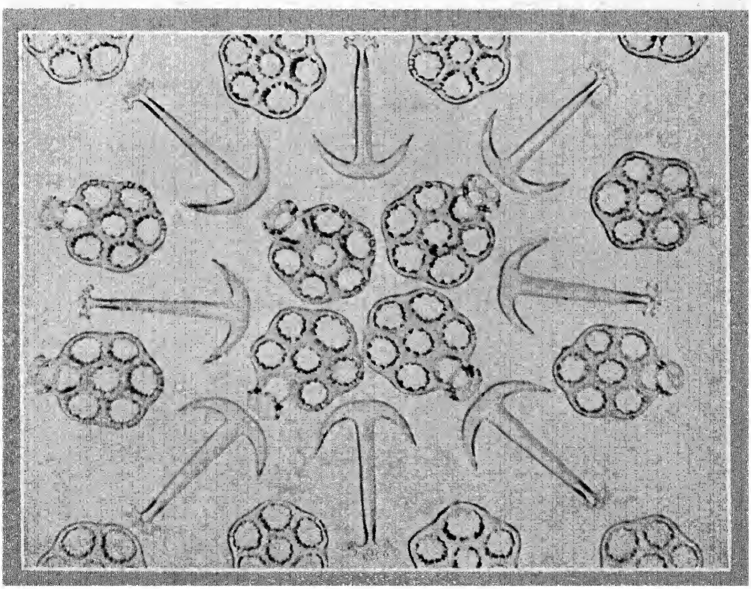
There is a definite reason for the right-angled notch in the front margins of the valves, for in this way a large gap is left between them, affording space for the foot of the Ship-worm to be protruded, and to act as a sucker, which adheres now to one

part and now to another surface of the interior of the burrow. Certain muscles attached to the valves act in such a way that a rocking, twisting movement is conveyed to the whole shell when boring operations are going on; and as the sucker-like foot changes from time to time its point of attachment, the wood is rasped away equally on all sides and the circular shape of the burrow is maintained. Under favourable conditions, if the ear is placed against a piece of timber infested by living Ship-worms, the rasping sounds of their operations can be distinctly heard.

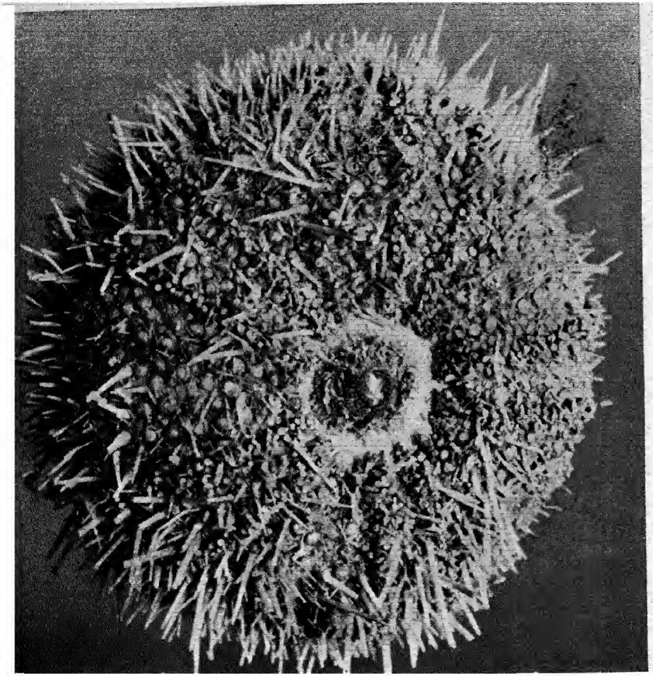
The Ship-worm is a skilful engineer, for though he must in most cases start to drive his tunnel at right angles to the grain, the miniature shaft soon turns to run with the grain of the wood, and will be continued in that direction until some obstacle, such as a knot or iron bolt, is met with, when the tunnel will be directed to one side. Like a modern engineer, too, the Ship-worm lines the walls of the shaft he is driving, not with steel plates, but with a layer of shelly material. Towards the inner end of the tunnel this layer is little more than the merest film, but near the opening it is considerably thicker; while in some species this lining is elaborated into a succession of inward projecting rings, which divide the tube partially into a series of chambers. As the Ship-worms always make their tunnels to run with the grain of the timber, the burrows in a badly attacked piece of wood may be so close together, that they are only separated from one another by a very thin layer. Nevertheless, the tunnels will



THE STARFISH
Crawls over the wet sand by means of its tube feet



The Wondeıful Plates and Anchors of Synapta are very beautiful objects when seen under the Microscope



Under Surface of the Common Sea-Urchin
Showing the circular mouth and projecting, sharp-pointed teeth

The Upper Surface of the Heart Urchin

never be found to break into one another. If a baulk of badly infested timber is carefully opened up, so that the course of the tunnels can be traced, it will be seen that wherever a Ship-worm has been on the point of breaking through into a neighbouring shaft, the little creature has withdrawn for an inch or two, and started its operations afresh, generally at right angles to its original course.

It seems probable that the Ship-worm does not always continue to burrow during the whole of its life, and that there is a cessation of these operations when the creature has attained to the limits of its growth, for, in some cases, the Ship-worm will be found to have withdrawn a short distance from the head of its burrow, and to have shut itself off therefrom by a dome-shaped partition, which is continuous with the shelly lining of the tunnel, so that the animal is nowhere in contact with the wood. This fact has an important bearing on the somewhat vexed question of the food of the Ship-worm, for there has been a good deal of discussion as to whether the animal feeds on the wood through which it burrows, or whether, like its non-burrowing relations, it depends entirely for food upon the microscopic forms of life which are swept in by the respiratory current of the siphon tubes. There are certain peculiarities in the structure of the food-canal of the Ship-worm, which appear to be special adaptations for dealing with a bulky but relatively non-nutritious form of food, and a good deal of fine sawdust collected from the rasping operations may be present in the canal.

It is certain, however, that the microscopic organisms, brought in by the respiratory currents, form at least part of the food supply, and must constitute the whole when once the creature has completely shut itself off from the wood by the shelly partition just described.

Let us now attempt to trace the life-history of this expert marine borer. The breeding season in our coastal waters and on the coast of Holland is during the summer months, probably from towards the end of May to the beginning or middle of September, as the young are found settling on wood during July and September. The fertilised egg of the Ship-worm develops in a few hours into a minute creature, called the larva, which swims freely about in the sea by means of a circlet of waving hairs or "cilia." Exactly how long the little creature enjoys this active, free-swimming existence has not been definitely established, though various estimates have been made, varying from a few days to as long as a month. It is only during this active period, however, that the creature possesses the power of locomotion, which will suffice to carry it to a spot where it can attack previously uninfected timber. At the end of this free-swimming stage, the little larva settles on the surface of a piece of submerged timber. The circlet of waving cilia by which it was able to swim through the sea disappears, but it is now able to crawl about by means of a strong tongue-shaped foot, which protrudes far beyond the bivalved shell that, at this period, encloses the whole of the body, and gives the little creature

rather the appearance of a tiny cockle. A special gland in the foot secretes a sticky thread called the byssus, by which the Ship-worm anchors itself when it has found a suitable surface on which to start boring operations. At this stage of its life, the Ship-worm is very small, little more than the one-hundredth of an inch, and the hole which forms the entrance to the future burrow is proportionately minute, so that, although this point of entrance may in course of time be slightly enlarged, it remains little more than a fair sized pinhole, even when the Ship-worm has attained to its full size within the burrow. Indeed, these small openings are often the only indication that a baulk of timber has been attacked, though the interior be riddled with tunnels.

The species of Ship-worm (*Teredo navalis*) which appears to cause most of the damage on our East Coast, in the Thames estuary, and also on the coast of Holland, measures, when full grown, from twelve to sixteen inches in length, while its burrow is about one-fifth of an inch in diameter. My friend, Dr. Orton, of Plymouth, who has kept this species under observation, found that the animal excavated a burrow eleven inches long in thirty-one weeks. He also found specimens to be alive a fortnight after the wood containing them had been taken from the sea, and draws attention to the fact that consequently these animals would be able to live easily during the period for which most vessels would be in dry dock for scraping and painting. There are three species of Ship-worm common round our coasts, and their life-histories and habits appear to be identical.

Ship-worms appear to have an almost world-wide distribution, for species are found from within the Arctic circle to Australia, New Zealand, and the Tropic seas. Hardness of wood seems to be a matter of indifference to these animals, for oak and teak are as readily attacked, and almost as quickly destroyed as the softer kinds. All sorts of paints and pickles have been devised for protecting the surface of timber, mostly with little permanent success, for a small abrasion of the treated surface will be all sufficient to lead to serious damage.

After the Ship-worms, the most important destroyers of submarine timbers are two small crustaceans called the Gribble (*Limnoria lignorum*), and the Chelura (*Chelura terebrans*). These two animals differ from one another both in size and general appearance, but are almost invariably found working in the same piece of timber.

In general appearance, the Gribble somewhat reminds one of a small wood-louse, rarely exceeding a quarter of an inch in length. For walking and clinging to the wood, it has no less than seven pairs of legs, terminating in sharp curved claws, while its jaws are well developed for the purpose of gnawing away at the timber in the process of excavating its burrow. The body of the Gribble is semi-cylindrical in shape, and divided into many segments, mottled yellow and black in colour. Under the broad tail-plate there are five pairs of appendages which serve the double purpose of gills, and paddles which can be used when the little creature elects to go for a swim. When the Gribble is at rest, or

excavating its burrow, the gills all the time keep up a steady fanning motion, producing thereby a regular current, which serves to draw in and renew the water needed for respiration.

The Chelura is easily distinguished from the Gribble by its slightly larger size, and rose-pink colour, spotted with white. Also it has larger and stronger horns, or antennæ, as they are called, on its head, and a remarkable pair of tail appendages.

While the burrows made by the full-grown Gribble are about one-fifteenth to one-twentieth of an inch wide, those of the Chelura are larger, reaching to quite one-tenth of an inch in diameter. The burrows generally run obliquely to the surface of the wood, and at no great depth, rarely more than half an inch from the surface, and about two inches in length. As these burrows break into each other in all directions, the superficial layer of wood is rapidly reduced to a spongy mass, which is easily washed away by the action of the waves, so that deeper and deeper layers are constantly being laid open to attack, and, in time, the timber may be completely destroyed. Both the Gribble and the Chelura have been found also boring into the insulating covering of submarine telegraph cables at depths of 200 to 290 fathoms, so that, although they are individually so insignificant in size, these two small crustaceans, so numerous between tide marks and at greater depths, are really formidable foes to the marine engineer, and the amount of damage they have caused to wooden breakwaters and piers probably runs into millions of pounds.

But the Wood-borers are by no means the only foes that the builders of docks and groins have to contend with.

There are various marine animals which bore in to rocks and will also attack concrete, particularly where rubble composed of a calcareous or friable rock has been used for mixing with the cement. Anyone who wishes to see an example of an engineering structure suffering from such attacks might well pay a visit to Plymouth breakwater, where the limestone blocks show the most unmistakable evidence of the work of these boring animals. To quote from a report by Dr. E. J. Allen, F.R.S., the Director of the Marine Biological Laboratory, at Plymouth: "In a stone which has been injured through this cause the outer surface, to a depth of about a quarter of an inch, is converted into a honey-combed friable mass through the boring sponge, *Cliona celata*, whilst at frequent intervals large holes, each of which may have a diameter of a quarter of an inch, and may pierce the stone to a depth of one inch, are formed by the boring mollusc *Saxicava rugosa* (the Wrinkled Rock-borer). To these two animals most of the damage is due, but in addition many of the Polychætes (Marine Worms), form holes of oval or figure of eight section, which may penetrate for a depth of several inches into the heart of the stone."

The Wrinkled Rock-borer, mentioned by Dr. Allen in his report, is a very common mollusc round our coasts, though probably seldom seen by casual holiday-makers at the seaside, for one must know

where to seek it and how to chip it out from the snug burrow it has made in the rock. The shell of this stone-borer has rather an odd, misshapened appearance, due to its being pinched in at the middle of the lower portion of the shell, and also to its great thickness in front, one valve frequently being larger than the other. In colour the shell is a dirty white, and has a dull rough surface which is irregularly wrinkled in concentric fashion. The animal, itself, is whitish, tinged with yellow, while the two pink-tipped tubes or syphons, which form part of its breathing apparatus, are capable of considerable extension beyond the shell, and are covered for the greater part of their length by a brown sheath. One is pretty certain of finding specimens wherever the shore at low-water mark shows masses of chalk, limestone, or red sandstone.

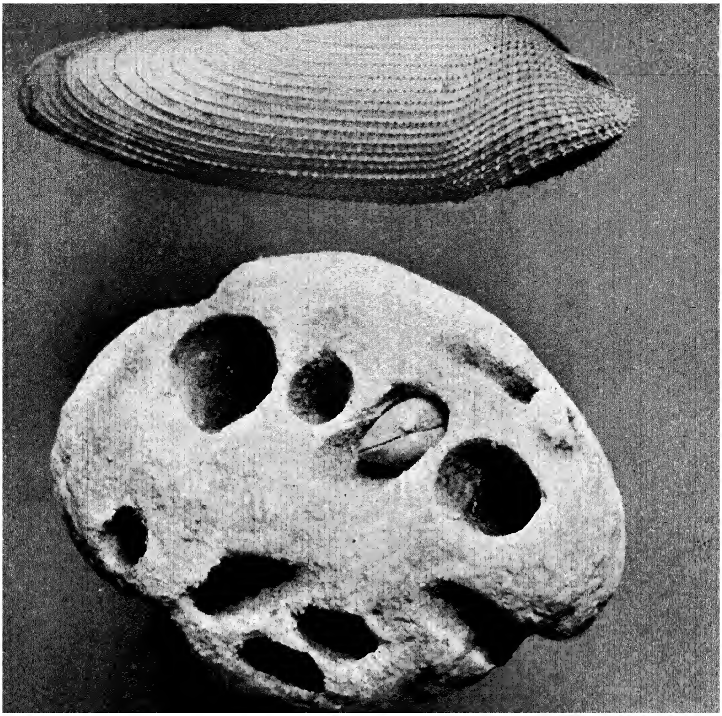
Exactly how this little mollusc bores into the rocks is still a somewhat uncertain and disputed point, for it is often found in limestone so hard and compact that it seems impossible to credit the relatively fragile shell with having successfully excavated the chamber by mechanical means alone; yet, no special acid-secreting gland has been detected in either the mantle or body of the animal. However, the theory of a mechanical process of excavation is given strong support by the fact that this mollusc is not infrequently found in soft, non-calcareous sandstones, which would not be attacked by acids.

Another group of rock-boring molluscs is formed by the Piddocks. The largest is the so-called

Common Piddock (*Pholas dactylus*), whose elongated shell often measures five to six inches in length, while the excavated chamber in the rock may be a good twelve inches in depth.

The shell of the Common Piddock is really an admirable rasp, for, on its outer surface, each valve is traversed by some forty to fifty rows of prickly teeth or spines, which are chiefly developed on the front portion of the shell. That these rows of spines play an important part, probably the chief part in the boring operations of the mollusc, appears evident from the fact that, while specimens taken out of chalk or other soft material are found to have their spines in a sharp and slender condition, others obtained from harder rocks have their spines blunted and rounded. The Piddock makes a vertical and fairly symmetrical burrow, and will sink its shaft in to a variety of substances, including limestone, sandstone, shale, mica-schist, and even peat, but rarely if ever in to such hard and compact rocks as those in which the Wrinkled Rock-borer is sometimes to be found.

It is quite possible for anyone, who will exercise a little trouble and patience, to see something of the means by which the Piddock excavates its chamber in the rock. If a piece of chalk or other rock containing a living Piddock be placed in a sizeable glass jar filled with sea water, which must be changed at least once in every twenty-four hours, or be aerated by means of a syringe or bicycle pump to keep up the supply of oxygen, the mollusc will feel more or less at home and proceed with its work at regular



THE PIDDOCK'S RASP-LIKE SHELL
And a rock bored by the wrinkled rock-borer

THE LITTLE CHELURA
A most destructive crustacean that bores into marine timbers and cables

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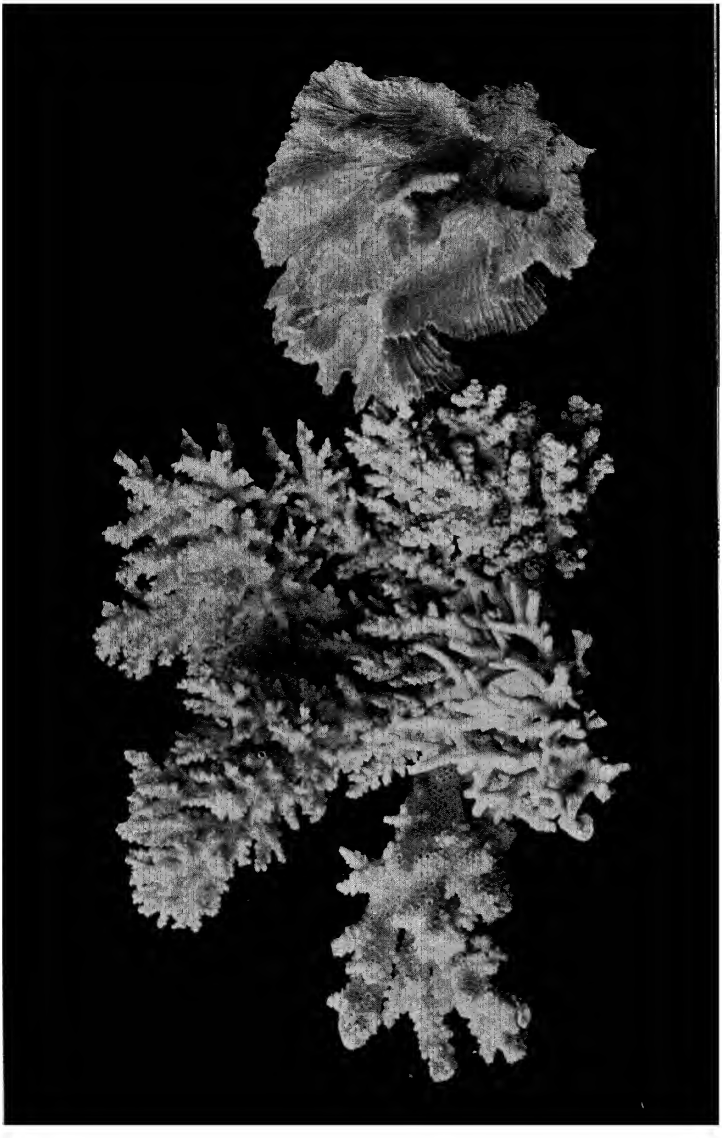

A Group of Reef-building Corals

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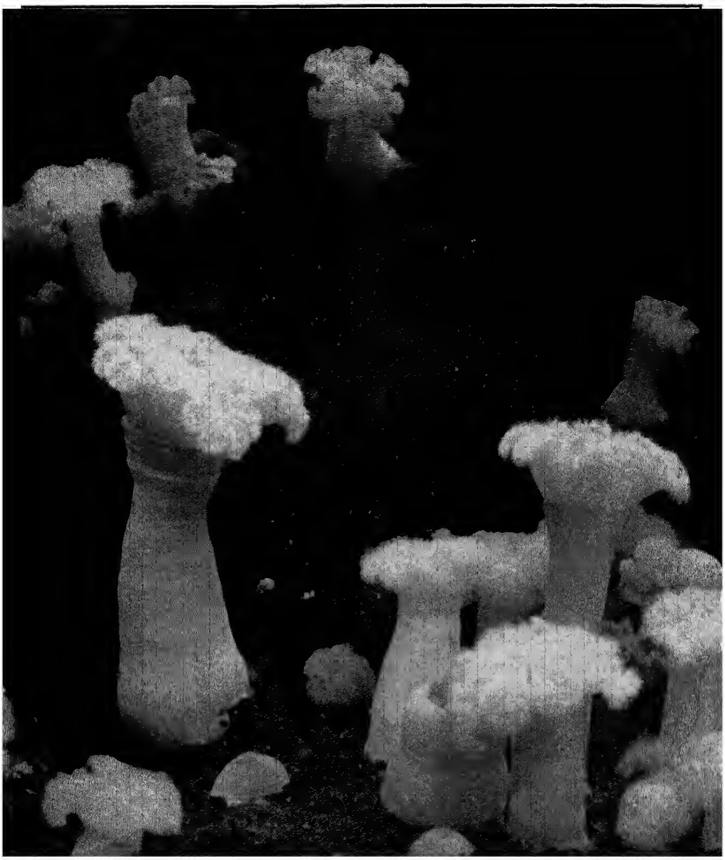
intervals. The process of excavating will then be seen to be chiefly accomplished by a twisting, rocking movement of the shell, the stout sucker-like foot of the Piddock forming a fulcrum. In this way the armoured portion of the valves, covered with rows of prickly spines, is brought to bear upon the surface of the rock like a pair of rasps.

The Polychæte worms, which Dr. Allen describes as boring into the stonework of the great break-water at Plymouth, are for the most part minute in size, but are known at times to occur in large numbers. Their exact method of boring into the rock does not appear as yet to have been satisfactorily established, but it would seem that, while there may be some abrasion of the rock by the horny bristles with which the feet of these worms are well supplied, the real factor must be a chemical solvent secreted by the worm, acting on the hard limestone in such a manner as to render it easily disintegrated.

During a ramble at low tide along the shore, one may often pick up an old oyster shell whose surface is covered with little round holes about the one-twentieth of an inch in diameter, which are the work of the small rock-and-shell boring Sponge called Cliona. In addition to old shells, this Sponge also bores into limestone, though its excavations rarely exceed a couple of inches in depth. Here again we may look for a chemical solvent of the lime of the shell or rock attacked, rather than a process of friction, although the movement of the fine silicious spicules, which form a supporting framework to the tissues of the sponge, may help in the process

to a small degree. Although this boring sponge is small at first, it gradually increases in size, for below the surface of the shell or rock the burrows connect with each other, so that by the time the oyster shell, for instance, has been disintegrated, the Cliona may grow into a mass of considerable size. Indeed, of recent years it has been discovered that the well-known Neptune's Cup Sponge, which sometimes attains to a height of several feet, is really the full grown adult form of a species of Cliona.



THE GRACEFUL, GAILY-TINTED SEA ANEMONES
Are closely related to the Corals

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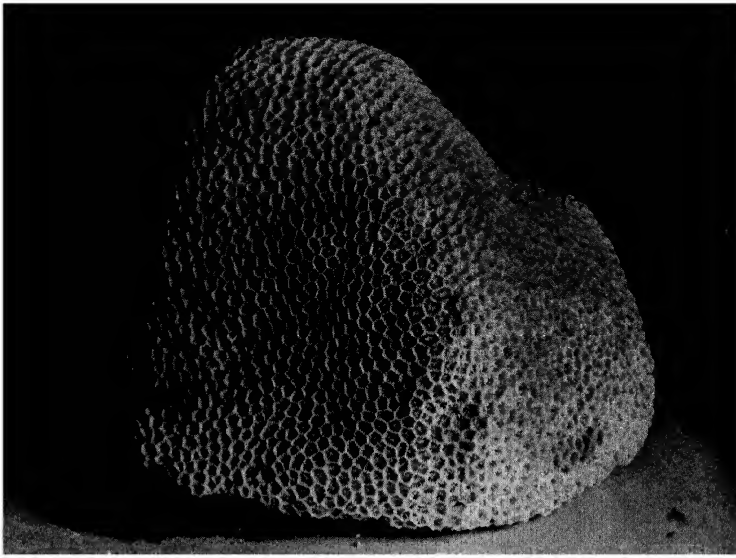

Massive Porites Coral of the Outer Reef

A Fine Example of a Neptune's Cup Colony of the Turbinaria Coral

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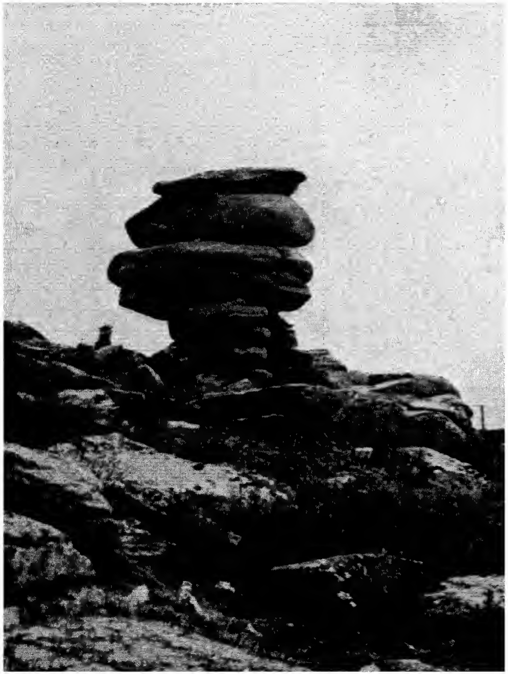
Under suitable conditions of environment the growth of reef-building Corals appears to be rapid, thus massive Porites heads grow upwards about 18 mm., branched Porites 30 mm., Pocillopora 38 mm., and Acropora 55 mm., per annum. From these figures a reef of massive Porites might possibly grow upwards 100 feet in 1600 years. Professor Stanley Gardiner has estimated that in the Maldives a coral reef might become 100 feet thick in 1150 years. It seems probable that in many instances reefs now living in the Pacific are structures which have originated in geologically modern times upon submerged slopes and platforms of marine erosion.

EARTH-SCULPTURE

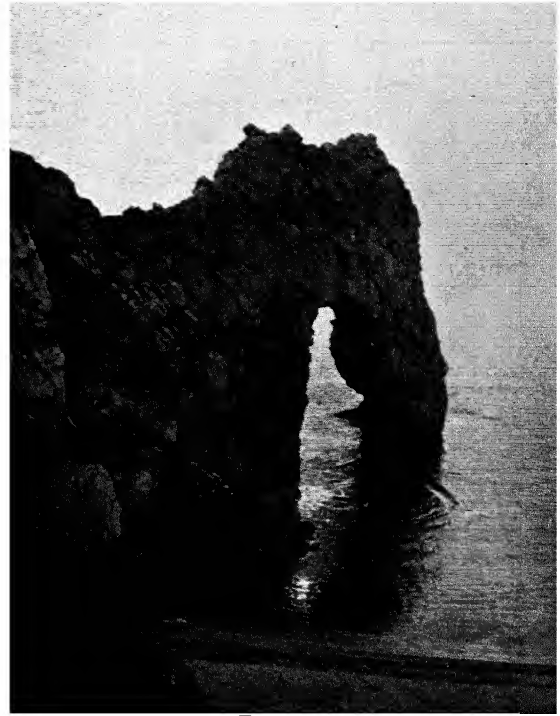
> "There rolls the deep where grew the tree
>   O earth, what changes hast thou seen!
>   There where the long street roars, hath been
> The stillness of the central sea.
> The hills are shadows, and they flow
>   From form to form, and nothing stands;
>   They melt like mist, the solid lands,
> Like clouds they shape themselves and go."
>
> TENNYSON.

THERE appeared recently in the public Press the records of two instances of the ever-changing face of Nature that might well help to recall to our minds the truth of those exquisite lines from Tennyson's "In Memoriam." The first was the laying bare, by the action of the waves, of an ancient fossil forest in a bay in the Channel Islands; the second, the news of the appalling disaster due to violent earthquakes in western central Japan, said to be the worst seismic disturbance in that region since 1854.

I suppose, to most of us, it is chiefly through the news of some mighty earth tremor, or terrible volcanic outburst, carrying in its train death and destruction, that the fact that the face of the Earth continues to change is brought home. Yet these sudden and awe-inspiring upheavals really play a very insignificant part, though helping to produce



THE CHEESE-RING ON DARTMOOR
Is an ancient mass of weathered granite



DURDLEDOOR
A beautiful natural arch on the Dorset coast

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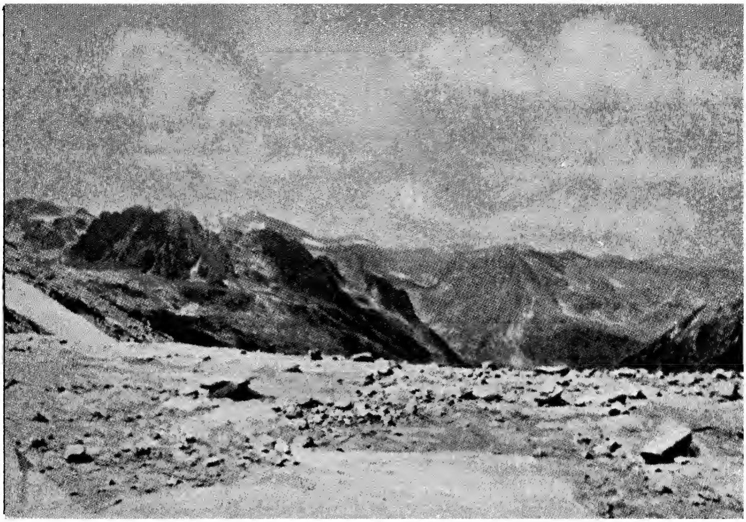

These masses of rock have been split from the sides of the mountain by Nature's Ice Chisel, and have fallen on to the glacier which will ultimately carry them down to the valley.

At Stair Cove, Lulworth, we see how the horizontal beds have been bent into curves, and even thrust up on end.

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example. It is a massive creature, attaining a length of fifty-four or fifty-six feet, the great head being about one-fourth of the entire length of the animal, while the lower jaw is more highly arched, and the whalebone considerably shorter than in the Bowhead or Greenland Whale. This species was persistently hunted by the Basque fishermen of the Biscayan ports from the tenth to the sixteenth century, when the discovery of Spitzbergen in 1596 caused them to turn their attention to the more valuable Bowhead Whale.

Rorquals or Fin-Whales are distinguished from the Right Whales by the shorter and flatter head, their narrow flippers and long slender body, the presence of a fin on the back, and of deep parallel grooves or furrows in the skin of the neck. These characteristic furrows are a special mechanism to allow of the expansion of the region in which they are placed, so as to form a capacious pouch, capable of taking in a large bulk of water containing great quantities of small marine animals, such as fishes and crustaceans and molluscs. On contracting the pouch, the water is driven out through the meshes of the sieve formed by the whalebone, and the "catch" remains behind to be swallowed. It is only since the introduction of modern methods of whaling, and the use of explosive harpoons fired from guns, that the Rorquals or Finners, as they are popularly called, have been seriously hunted, for their great speed, the shortness of their whalebone, and comparatively limited amount of oil-producing blubber rendered them unprofitable under

rolling clouds and soaking mist that filled every crack and cranny in the rocks with water. As night came on the temperature gradually fell, coating the moisture-laden rocks with frost, and converting the rain that had accumulated in the fissures into solid ice. It is at the moment of conversion into solid ice that expansion takes place, for water as it grows colder contracts in bulk, until it falls to a temperature of about 4° C., only on reaching O° C. to suddenly expand. That is why a tumbler containing fluid, if left out on our window sill on a frosty night, will be found cracked the following morning, the fracture being caused by the expansion of the water at the moment it was frozen into solid ice. As we climb the mountain side the following morning, with the sun shining gloriously, we shall soon begin to hear the tinkle of water from the melting ice, and the sharp sound of falling fragments of rock now released by the thawing of the ice. In high Alpine districts these falling pieces of rock, that have been split off from the main mass by the action of ice, constitute a grave danger to the traveller, not only on account of their sharp edges and weight, but because they may start a field of snow and debris to sweep down the mountain side as an avalanche, engulfing all objects that lie in its path. Some of the masses of rock dislodged by Nature's ice-chisel will fall upon the surface of the glacier, that great ice-river which winds down from the snow-clad heights of perpetual cold, down to the broad valley, where from its base flows a mighty river that will wind through the rich pasture lands,

across the plains to the sea. In that long slow journey down the mountain, the masses of rock embedded in the glacier will be ground and pressed against the stony sides of the cliffs, so that they become deeply scored and graven with the message of their transit.

Although we have no glaciers in England to-day, unmistakable evidence of their existence here in the past are to be found in many parts of the country, in the Lakes, Cumberland, Yorkshire, Wales and Scotland, both by the ice-worn boulders they have left stranded on the hills, and by the configuration of the valleys. The Pass of Llanberis is a fine example, and the Pass of Glencoe owes its wild, romantic beauty to the passage of a great glacier in a long past geological epoch.

As we read of the dreadful devastation caused by some violent volcanic outburst in distant lands, we may well be thankful that such sudden upheavals are unknown to-day in this densely populated island home of ours. But it was not always so. The romantic beauty of Arthur's Seat and Salisbury Crags at Edinburgh are the result of violent volcanic action in the past. The heights of Dartmoor and Cornwall tell their story of ancient lava flows, and the wonderful basaltic columns of the Giant's Causeway and Fingal's Cave were formed in volcanic lava flows of the long ago, during that epoch of the Earth's history which the geologist has named the Tertiary Period.

Sunshine, wind and rain are the tools employed by Nature in modelling the features of sandstone districts, often with startling results, as may be

seen among the weird shapes of the Brimham Rocks in Yorkshire, the ancient Toad Rock at Tunbridge Wells, and the Agglestone, near Studland, in Dorset. There is a queer old legend attached to the Agglestone, which relates that the Devil, while on a visit to the Isle of Wight, was so enraged when he saw the monks at work building Salisbury Cathedral that he seized this gigantic mass of sandstone and hurled it with all his force at the cathedral, hoping to obliterate it. But the Agglestone was miraculously arrested in full flight, and sank harmlessly to rest upon the low sandy hilltop where it has remained ever since.

Now the Dorset coast, and more particularly that portion which forms the seaward boundary of the Isle of Purbeck, is of quite extraordinary interest in the wealth of examples it contains of Nature's varied methods of Earth-sculpture, of building up and of destruction. If we roam over the wild wide stretch of country between Poole Harbour and Studland Bay, we can trace every step in the growth of the sand-dunes as they march inland from the shore. The prevailing on-shore winds dry and blow the sand up the gentle slope to the inland margin of the shore, where the surface is more or less uneven and partially clothed with a scanty vegetation of reeds and coarse grasses. There the sand becomes heaped up among the stems of the plants, and, like drifting snow, gradually fills up all the hollows. Through the agency of these grasses and sedges, which bind and arrest the shifting sands, the dunes are gradually formed, and as we follow them inland

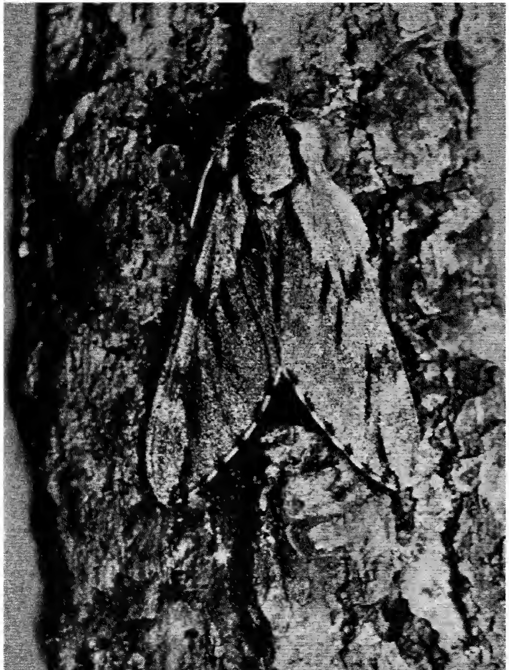
we find them rising higher and higher, until we come to a point where they slope down to the margin of a beautiful reed-bordered lagoon, locally called the "Little Sea": the haunt in spring and autumn of many wading birds.

If we take a boat round from Studland to Swanage we shall pass under the majestic heights of the great Ballard Down, that towers up, a gleaming mass of white chalk, into the deep blue of the summer sky. At the Studland end we see the regular horizontal layers or bands of flint, but about halfway between there and Swanage the bands are seen to have been forced up from the horizontal to the vertical—a record on the face of the cliff of stupendous force and earth movement. We must remember that all those hundreds of feet of gleaming chalk were first formed at the bottom of an ancient sea, just as new chalk is being formed to-day at the bottom of the Atlantic, and that very slowly in the passage of the ages it has risen higher and higher, and later has been gradually moulded by the action of the wind, rain, frost, and sunshine into its present form.

Between Swanage and that beautiful natural arch, called Durdledoor, below Lulworth, we may explore the wonders of the Wealden formation, the thickness of which series at Swanage is computed at not less than 2,000 feet. No figures can convey to the human mind the period of time required for the formation of the Wealden and Purbeck strata, though the rich fossil remains help us to realise something of the conditions of life and climate

during which they were forming. We must try to picture a great delta covering an area of some 30,000 square miles, and through which a wide and noble river flowed slowly down to an ancient sea. Mare's-tails or gigantic Equisetums grew in, the marshes, and beautiful ferns, Zamias and Cycads flourished on the drier ground, while crocodiles, turtles, fishes and mollusca swarmed in the waters of this ancient river, and on its banks those gigantic reptiles, the Iguanodon and Megalosaurus, had their home, and the strange, winged, bird-reptile, the Pterodactyl, chased and captured the insects that flitted through the groves, in the warm tropic air of a climate not unlike that of Malaya and New Zealand of to-day. Gradually, this ancient delta was submerged, with its forests and animal and insect life, beneath a body of fresh water from which sediment was thrown down. The sea slowly encroached and left its record in a great stratum, some twelve feet thick, composed of a vast bed of fossil oyster shells, known locally as the "Cinder-bed." Gradually, the land sank lower and the sea deepened, so that the chalk of which the Ballard Fault and the downs surrounding Lulworth Cove are formed was deposited. Then the land began to rise again, until the chalk, the "Cinder-bed," the fossil forest and ancient delta assumed their present position high above the sea. At Lulworth Cove we can see that this gradual uplift was attended by immense leverage and pressure, for the once horizontal beds of strata are curved and bent in the most wonderful and awe-inspiring fashion, giving us unmistakable

evidence of great seismic disturbance in the long past. Who can gaze upon those wonderful cliffs without being deeply impressed by their infinite grandeur, and by the mighty forces that have moulded them? Amidst such majestic surroundings, with the soft murmur of the wind and waves in our ears, how insignificant and poor the work of man becomes; how base and paltry the greed and strife, the hate and petty meanness and utter selfishness of his vaunted twentieth-century civilisation. On the mountains and in the valley, on the wind-kissed cliffs and by the murmuring sea, we may draw nearer to the Infinite, find comfort and renewed hope, and something of that peace which passeth understanding, if we will but strive to throw from us the vanity, selfishness and greed of modern life, and humbly seek to learn a little of the fundamental truths of Life thus spread out before us.



THE PINE HAWK MOTH AT REST

So closely resembles the old oak on which it rests as to become invisible at a short distance

THE BEAUTIFUL CLIFDEN NONPAREIL MOTH

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Very early in the history of animal life on this old Earth of ours, we find evidence of the existence of many highly specialised forms of insects, long ages before man had made his appearance. Take, for example, that period of the Earth's history when all England had a tropical climate, and our great coalfields were dense forests and marshes, supporting a strange but luxuriant growth of plant life, there were forms that have totally disappeared, or have, in many cases, degenerated into small and insignificant wayside weeds. So with all those strange and hideous forms of reptilian life that roamed the forest glades and peopled the lakes and marshes; they have all disappeared completely, leaving nothing but their fossilised bones to tell us of their ungainly shapes, and unlovely existence. But the same coal-measures which reveal to us the fossil remains of that strange and wonderful period of plant and reptilian life, also provide us with ample evidence of the high perfection to which insect life had already attained. Many a fossil tree trunk and branch shows the same borings caused by burrowing larvæ and beetles, whose direct descendants, but little changed in appearance, and not at all in habits, are to be found to-day, gnawing at the living tree, and burrowing into the oaken rafters of our ancient halls and churches. Large dragon-flies hawked across the surface of the pools and rested on the stems of the tall reeds; butterflies and moths flitted through the forest glades and across the open spaces; and flies blundered into the snares spread by their hereditary enemies—the

spiders. Yes, from all the evidence obtainable from abundant fossil remains, there is little doubt that the insect life of the forests of the coal-measures, of the Carboniferous Period as it is termed, differed but little from the insect life of the tropical forests of to-day, either in form, habits or life-history.

The foes of insects are very numerous, and have always been so. They are preyed upon by birds, by a few mammals, by reptiles and fish, by spiders and scorpions; and they prey upon each other, for a whole host of species of solitary wasps and Ichneumon-wasps prey upon their more defenceless relations. Insects are also subject to microbic and other diseases, causing widespread epidemics that threaten the extinction of the species attacked. But so prolific are these creatures, so readily do they respond to anything approaching favourable conditions, that, though the stock be reduced almost to vanishing point, the surviving remnant is nearly always sufficient to carry on and to perpetuate the species.

Surrounded by a host of watchful foes, he who can best escape notice either by unostentatiously mingling with his surroundings or pretending to be something or somebody else, is the most likely to perpetuate his species. Therefore, it is not surprising to find that among the inhabitants of the insect world camouflage, or protective mimicry, has long been a fine art. Down through the long ages the laws of natural selection have gradually

moulded and adapted these more or less defenceless creatures to their environment, and has supplied them with the means to escape their numerous enemies.

Concealment naturally suggests itself as the simplest and most effective way in which to escape the unwelcome attentions of a blood-thirsty foe, and in this game of hide and seek success largely turns on protective colouration. Consequently, we find that a large number of insects are protectively coloured, the tints and markings on their bodies and wings closely matching the bark of the trees, the twigs and leaves, the moss or lichens among which they spend their lives.

Most of our night-flying moths afford striking examples of such protective colouring, and, resting motionless during the hours of daylight on the trunks of trees, amidst grass-stems or fallen leaves, completely escape notice. The large and handsome Clifden Nonpareil rests during the daytime upon the trunks of oak trees and upon old oak park palings, the soft grey colourings and markings on its broad upper wings harmonising so wonderfully with the surface upon which it rests, as to make it quite invisible at a distance of five feet. The beautiful Pine Hawk Moth, easily seen at dusk as it flits past like a grey-winged forest fairy, takes a keen and practised eye to find during the daytime, when it rests with closely folded wings upon the mottled trunk of some sheltering pine tree.

Every gardener knows, to his cost, how successful is the protective colouring of most of the caterpillars that devour his favourite plants, so that though he search ever so carefully, many will escape his notice and continue their ravages, safe in their livery of green and soft bars and stripes of brown. And yet many of these caterpillars, when taken away from their natural surroundings, look so bright in colour and brilliant marking, that it is difficult to believe one could ever miss seeing them. Take, for example, the large and handsome caterpillar of the Privet Hawk Moth, with its brilliant green body and purple markings, making it appear such a striking and conspicuous object when drawn or photographed; yet it is those very bars of vivid colour which help to break up the outline of its body while the caterpillar rests amidst its natural surroundings.

In the caterpillars of the Geometer Moths, commonly called "loopers," form as well as colour plays an important part in their disguise, for they all mimic very closely the twigs and shoots of their particular food-plants, such as the Blackthorn, May, Elder and Plum. Clasping with their hindlegs the stem of the bush or tree upon whose foliage they are feeding, the "loopers," when alarmed, will bend their bodies outward at a sharp angle and remain in that position, absolutely motionless, until the fear of danger has passed. And so closely do they resemble, when in that position, the colouration and form of short twigs and leaf-stalks, that they are well nigh impossible to detect. Watch a Blue

or a Great Tit hunting for these caterpillars, and notice how the wee birds circle round each branch, moving their heads from side to side in their search, and you will realise how shrewdly even these feathered experts have to scrutinise the branches in their hunt for insect provender for their offspring.

To see the brown and yellow leaves of a sun-scorched bush suddenly fly away is one of those startling incidents which the visitor to certain parts of India may experience, should he be there when the beautiful Indian Leaf-Butterfly (*Kallima*) is on the wing. The upper surface of the wings of this large and handsome insect are of a deep purple tint, with a band of rich orange colour across the fore-wings, making it a very conspicuous object when in flight. Yet when this brilliant butterfly alights on the branch of a tree in the dense forests that it frequents, it is immediately lost to view, for its wings, on their undersurface, are exact replicas of the withered leaves amidst which it has come to rest. Directly this butterfly settles on a branch, it folds its wings over its back, concealing its head at the same time between them; while the short, blunt tail, in which the hind wings terminate, rests upon the branch, and exactly imitates a leaf-stalk. A long curved line runs from the tapering tip of the fore-wing down to the short tail of the hind-wings, corresponding to the mid-rib of a leaf, while on either side of this camouflage mid-rib arise oblique markings representing veins. How extraordinarily closely the folded wings of this butterfly resemble

a brown withered leaf, is clearly shown in the photograph of two specimens in the author's collection here reproduced.

Some of the strangest examples of protective mimicry are to be found among the *Phasmidæ*, a family of insects belonging to the order *Orthoptera*, which also includes the more generally familiar Cockroach—the so-called "Black-Beetle." All the Phasmidæ mimic in shape and colour, leaves, sprays of moss, grass stems and twigs. They are chiefly inhabitants of the Tropics, where some species grow to a great size, measuring ten or twelve inches in length, and looking just like dead or withered branches. Nocturnal in their habits, these strange insects remain absolutely motionless throughout the day, clinging to the stems of the plants that form their natural habitat. But with the approach of dusk these fantastic dried twigs and plant-stems suddenly come to life, and proceed to creep slowly and stealthily about in search of food; some of them even unfurling cleverly hidden, yet brightly tinted gauzy wings, and taking flight through the warm night air. As the colour of the plants varies with the passing of the seasons, so do these strange insects change their tints; thus, after the heavy rains, when everything is refreshed and puts out new luxuriant growth, green leaf and stick insects abound, while later, as the vegetation withers and changes to yellow, russet and brown, a similar seasonal change of hue will predominate among these insects. In most, if not all species of stick insects, the females far outnumber the males, and

many generations will be produced without sexual intercourse, just as takes place among the "green-fly" in our gardens.

A particularly interesting member of this family is the remarkable Leaf-insect (*Phyllium siccifolium*), which resembles a large compound green leaf. It is an inhabitant of East India, where the natives firmly believe it to be a compound organism, half animal, half plant. Nor is this very surprising, for at every stage of its life the insect bears a strikingly plant-like appearance; even its eggs resembling plant seeds in form and colour.

In the Brazilian Grasshopper, figured on Plate we have an example of double protection, for while the wing cases look like withered leaves, the wings have a large eye pattern on their upper surface near the margin. When at rest this grasshopper does not completely fold the wings, but from time to time displays the "eyes," with quite a realistic effect, and it is highly probable that by the aid of this additional piece of camouflage succeeds in keeping some of his foes at a distance. These "eyes" are frequently met with on the wings of butterflies, and also on the wings of some moths. If the "eye" is on the upper surface, then the wings will remain expanded when the insect is at rest; while should the "eye" adorn the under surface, then the wings will be folded back to display it to full advantage. Probably these "eye" markings serve as a warning, and keep unwelcome visitors away.

Another interesting type of mimicry which is widely spread among insects consists of mimicking

a dangerous species, or a distasteful one. Several of our Clear-wing Hawk Moths, which are day-flying, harmless creatures, bear quite an extraordinary resemblance to the large Humble Bees and Wasps, and are quite difficult to distinguish from those members of the *Hymenoptera*, when seen flying about among the blossoms in the wonderful Rhododendron drive in the New Forest. Certain species of butterflies are more or less unpalatable, and are avoided by insect-eating birds. They are for the most part handsome and brightly coloured; red, black and white, being frequently the dominating tints, and it is now known that several species of "edible" butterflies closely mimic them. In some of these mimetic species, it is the female that has assumed the disguise; the male in some instances being so totally dissimilar in appearance as to have been given a different name; its true relationship to the camouflaged female only being discovered later, when specimens were reared from season to season in captivity, and the whole life-history from the egg to the perfect butterfly recorded.

So far we have only been considering comparatively soft-bodied insects—caterpillars, butterflies and moths, grasshoppers, and the Leaf and Stick insects. But many equally interesting examples of protective mimicry are to be found among the *Coleoptera* or beetles, particularly among the smaller and less stoutly armoured forms. In the Tropics there are several very interesting small beetles that closely resemble in shape and colour certain species

The Indian Leaf Butterfly

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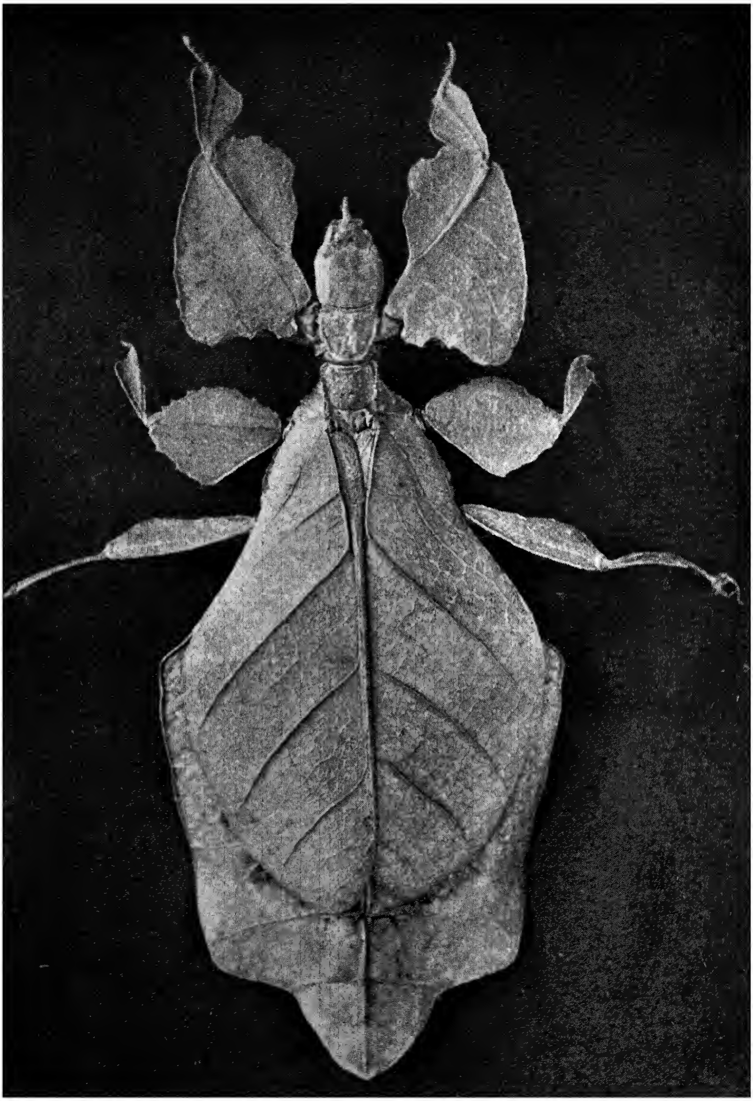

A PHASMID, OR LEAF INSECT

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of formidable ants; while one or two species mimic small ground spiders. As both ants and spiders are left severely alone by most creatures, and in fact possess very few foes, the defenceless beetles mimicking them must derive considerable benefit by their camouflage.

THE ROMANCE OF THE HONEY BEE

By the seeming wisdom of her ways and the perfection of her comb-building, by the wonderful modification of her little body and limbs, so perfectly adapted to her manner of life, the Honey Bee has long attracted the interest, curiosity and admiration of all who have chanced to see something of the busy life of the hive.

In the course of the long ages during which bee-keeping has been carried on and the ways of the Honey Bee more or less closely observed—the first apiculturist probably belonged to the very dawn of civilisation—something of the true significance of her life story has emerged, but much still remains to be learned about her, and we can still but dimly guess at the conditions and circumstances which ultimately led to the stark communal life of unceasing toil, almost from the cradle to the grave, with its sacrifice of sex and individuality, of individual reward or freedom, which is the dominant characteristic of the Honey Bee as we know her to-day. Man has had naught to do with it; for the life-cycle of the wild communities of Honey Bees, living in the hollows of old trees, in caves, in the roofs of old buildings and similar situations, is identical with that of the communities in the latest type of

wooden hive, or in the picturesque old basket skep in a cottage garden. We know that the ancestors of the Honey Bee did not live in communities consisting of a vast number of sterile females, or workers with one perfect fertile female, the queen-mother in their midst, and for a few weeks in the year, rearing and giving house-room to a limited number of males or drones who will be ruthlessly slaughtered once their function in life has been completed; but that they lived a free life as perfect males and females who paired, each couple responsible for its own small family, to carry on a normal individualistic life. Of the causes which brought about the profound change, as I have said, we still know but little.

In the early days of the year, when winter is gradually giving place to spring, a hive will be found to contain a queen-mother and a certain number of sterile females or workers who are survivors of the late broods of the previous year. All through the long cold winter months they have clustered closely together for warmth in the centre of the hive, with the precious queen-mother in their midst—most precious indeed, for were she to die during this season of the year, the community would soon cease to exist, she alone being able to produce eggs from which the spring brood of workers will arise. The winter has not been spent in complete torpidity of hibernation, however, for at regular intervals the Bees have drawn upon their supplies of food within the hive, although only taking just sufficient to keep life within their bodies; while, whenever the

sun has shone with sufficient warmth for an hour or so, they have left the hive for a cleansing flight. Many a Bee perishes at such times, overcome by cold and fatigue ere it can regain the safe shelter of the hive.

So soon as spring really sets in, the Bees rouse themselves and begin a thorough spring cleaning of the hive in preparation for the year's work. All is bustle and activity; some go forth to fetch in supplies of water from the nearest brook; others are at work upon the combs, cleaning and repairing them where necessary; and the dead bodies of all who have perished during the winter are brought out and carried to a distance from the hive. Every hour of sunshine sees a constant stream of Bees issuing from the hive to seek pollen and nectar among the opening flowers of the spring; while the comb-builders set to work to build new combs in which to store the spoils, and brood cells are prepared in which the queen-mother lays the first few eggs of the year.

At the commencement of the season the queen-mother only lays a few eggs daily, but as spring advances, and the combs are being well filled with honey and pollen, her production increases until at the height of the honey harvest she may lay from 1,500 to 2,000 eggs per day. The number of eggs laid, however, is regulated exactly to the requirements of the hive, for when work is plentiful and many labourers needed, the workers keep the queen-mother steadily at her task, constantly feeding her with food that stimulates her egg production; while, should the weather change to cold

and rain so that the Bees are unable to go forth from the hive to bring in liberal supplies, the workers reduce the amount of food given to the queen-mother, and her egg-laying at once decreases, or may almost cease for a period, until warmth and sunshine return.

As the queen-mother passes over the brood-comb, she is surrounded by a bevy of workers, who not only supply her with stimulating food, but keep watch to see that she only deposits one egg in each cell. The egg is oblong and is pearly white, and measures about one-sixteenth of an inch in length. It is slightly curved, and is larger at one end, while its surface is covered by a fine network of raised lines. The egg is always the same in outward appearance, no matter whether the germ within ultimately develop into a worker, a queen, or a drone or male Bee—that will depend in the case of queen and worker, upon the food supplied to the little creature during infancy.

The workers place a supply of food in the cell, beside the egg, so that the little legless, almost maggot-like grub or larva, on emerging, may find a meal awaiting it. This food is of a very special character, and may be considered as already partially or pre-digested, for it is regurgitated from the crop of the worker Bee, who generally spends the early days of her adult life as a nursemaid, being best able at this time to freely supply this special food, which has the appearance of a milky-white paste, very acid and pungent to the taste. Now it is the amount of this special food received during

the larval stage of its life that determines whether the little legless grub shall develop into a perfect female or queen, capable of laying fertile eggs from which workers and queens shall arise (the males or drones developing from eggs which pass from her unfertilised), or whether it shall grow up as a sterile female or worker incapable of reproducing its species. If the little creature is destined to become a queen-mother, then she will be fed entirely upon this complex food throughout her larval life; but if she is to become a sterile female or worker, then the special food will only be supplied during the first and second-days of her larval life; on the third day a mixture of pollen and honey will be added, after which the future worker or the drone will be fed chiefly upon these substances until they change to the pupa stage, during which no food can be absorbed, for that is the period when those profound changes of structure take place that convert the helpless grub into a perfect six-legged, winged Bee.

Let us for simplicity and clearness call the first or larval stage the childhood of the Bee. Three days after the egg has been deposited in the little cell in the brood comb by the queen-mother, the baby Bee emerges. The childhood of both the worker and the future queen may be said to last for eight days, but in the case of the male or drone Bee it lasts for ten days. At the end of this period the cell in which the little bee baby lives is closed with a porous cap specially manufactured by the attendant nurse bees. Three days later in the case of a worker, two days later if a queen, and four days later if a

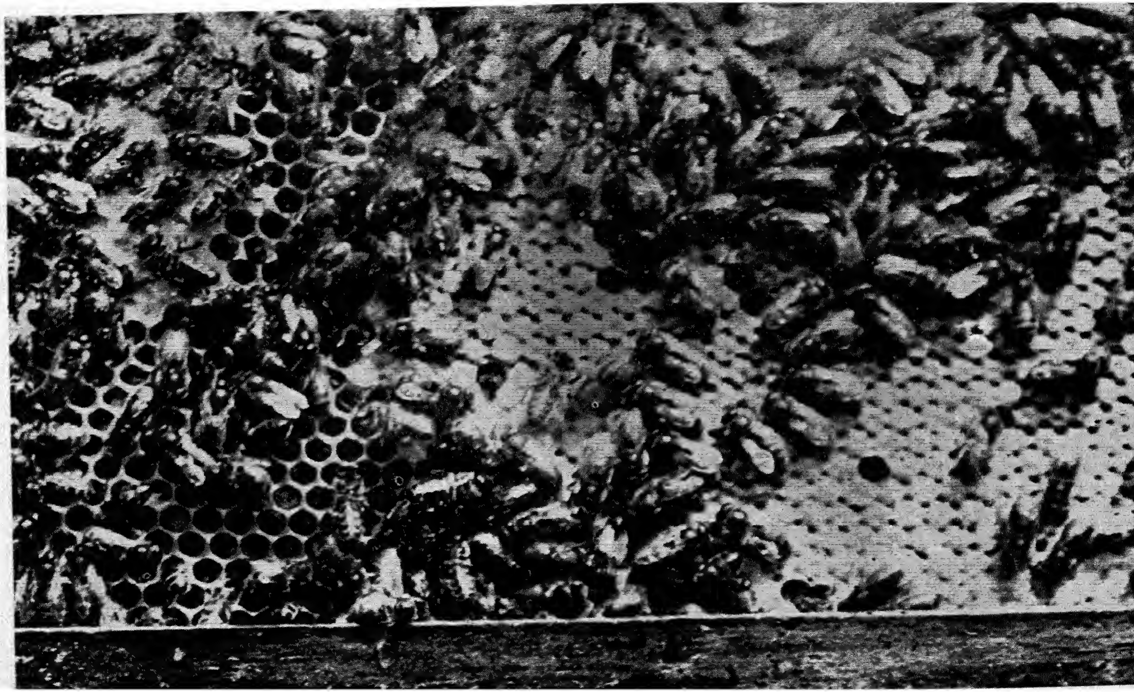
drone, the Bee baby casts its larval skin, becomes a pupa, and enters upon the second stage of its life-cycle. Here again, on the length of the pupa stage depends whether the individual is to become a worker, a queen, or a drone; ten days elapsing in the case of a worker, six days if a queen, and ten days if a drone, ere the perfect winged insect emerges from the cell to commence its active adult life.

As the spring advances, generally towards the middle of April, if all goes well with the population of the hive, a certain number of somewhat larger brood-cells will be formed by the workers, and in these the queen will deposit those eggs which in due course will develop into males, or drones, as they are popularly called. The queen, however, takes care that these eggs, as they pass from her, shall not be fertilised by sperms from the special receptacle or spermatheca within her body. So all drones may be said to be of virgin birth; indeed, on occasion a worker Bee, though physically incapable of mating, may have her ovaries sufficiently developed to permit of her laying a few eggs, but these will always develop into drones, never into a worker or a fertile queen. Although the queen can thus not only regulate the number, but also the kind of egg that she will lay, all her proceedings are really directed by the workers, and she is never allowed to use her own free will.

Soon after the drones have begun to appear, should the population of the hive be vigorous and strong in numbers, the workers will probably

decide to start building a few royal cells for the rearing of future queens. These are much larger than the ordinary cells in which the workers or drones are reared, and in size and shape somewhat resemble an acorn. Five or six of these royal cells may be made, and hung mouth-downwards, either in the middle or at the side of the brood-combs, in the very heart of the hive, where no harm may reach them. Whether the queen actually deposits the eggs in the royal cells, or whether they are transferred there from worker cells by the workers in attendance, appears to be uncertain; but the latter is probably the case. What is certain, however, is that the egg placed in a royal cell differs in no respect from those from which workers will arise, the difference in development being solely due to the treatment of the little creature during its larval life. Indeed, should the hive by some mischance be deprived of its queen, and no royal larvæ be available, the workers are able to rear a worker larva as a perfect queen, provided the little grub is only three days old, and therefore sufficiently young to respond to the stimulating diet with which a royal infant is fed throughout this critical period of its life.

On completing its metamorphosis the young princess, or future queen, is not permitted to leave the royal nursery, but is kept a close prisoner by the workers, who pass food into the cell through a small hole in the waxen cap. Only one queen can, under normal conditions, live in a hive at a time, and when, from the shrill piping of the



A View of a Portion of the Brood Comb
Showing eggs and larvae in the uncapped cells. The capped cells contain the pupae.

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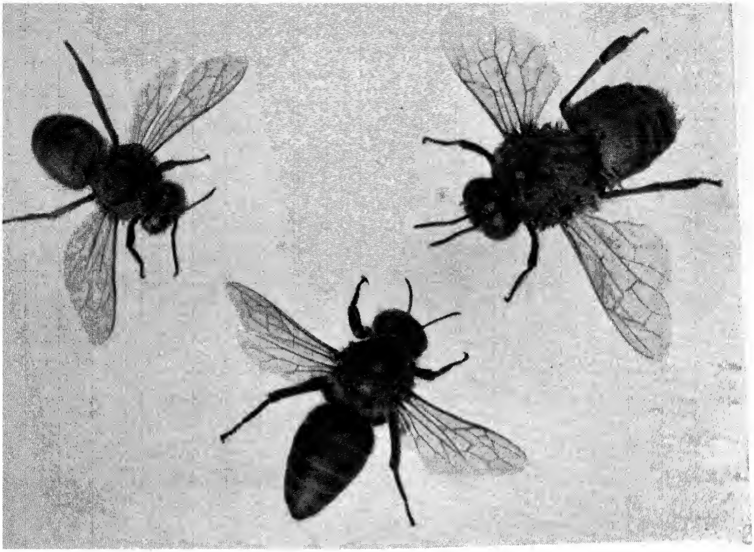
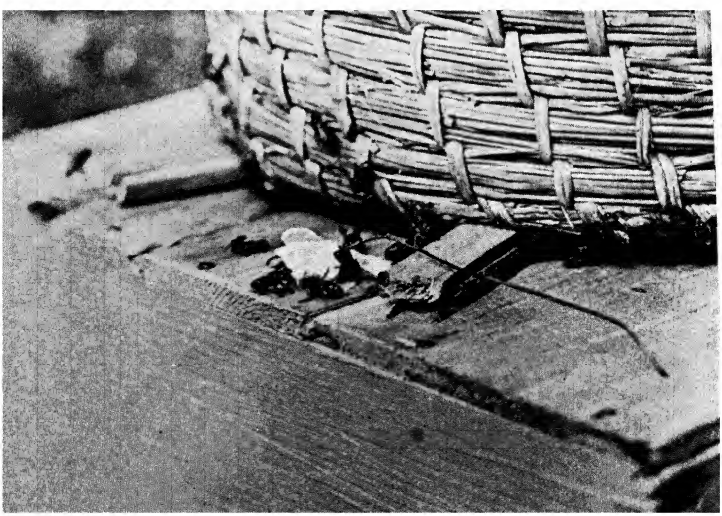


Worker and Drone, above: Queen, below



Worker Bees
Removing a flower that has fallen on the alighting board of the hive

imprisoned princess, the old queen knows that she has a rival, she grows greatly excited; and could she reach the royal cell would tear it open and destroy her offspring. But she is prevented by the workers, who bar her way and treat her with scant ceremony.

The old queen's excitement soon spreads through the hive, and general excitement and a cessation of normal conditions for a while prevails. In fact, the time for swarming has arrived. The Bees rush in and out of the hive swirling up into the warm summer sunshine like wreaths of smoke. They gorge themselves from the stores of honey, and presently the old queen is allowed to depart in the midst of the swarm to fly away and start a new colony.

After the old queen and the swarm have departed, the young princess is permitted to come from her cell, and for a day or two stays within the hive. Then, on a bright, sunny, morning, she comes out on to the alighting board of the hive, and, having become accustomed to the strong light, and taken stock of the position of her home, she departs on her nuptial flight, swiftly disappearing into the blue of the summer sky. The sturdy drones from the other hives, playing about among the flowers in the warm sunshine, have sensed her going, and with loud song give instant chase. The race is for the strongest and the fleetest, and somewhere far up in the summer sky a drone will overtake and mate with her, and, in but a little while, come tumbling earthward a corpse; while she will return to the

hive with the unmistakable evidence of her brief married life upon her. Once only does the queen have sexual intercourse, but the precious results are stored away within her body in a special sac called the spermatheca, so that each of the thousands of eggs she is destined to lay, with, of course, the exception of those from which drones will be developed, may be fertilised.

The worker Bees welcome the young queen back to the hive with every mark of pleasure and affection, and, if they have decided that no more swarms shall leave the hive, she is permitted to put every inmate of a royal cell to death with a thrust from her long curved ovipositor. Henceforth she will be the queen-mother of the hive, or until such time as she may, like her parent, depart as the leader of a swarm. A queen may live for four or five years, but she is rarely permitted to do so by the workers, who will put her to death directly she shows signs of a lessened power of egg-laying. At the end of two, or perhaps, three years, the queen begins to show signs that her powers of laying fertile eggs, capable of developing into workers or queens are decreasing, and then her days are numbered. The workers will not mercifully slay her with a thrust of their sharp stings, but they crowd round her, pressing closer and closer, until the breath is squeezed out of her body. Utility is the first maxim of bee life, and no aged, infirm or useless member is permitted to live within the hive. For queen or worker alike there is no holiday-making, no pleasant hours of rest or recreation, one and all will spend their

lives in almost ceaseless unrewarded toil for the common cause of the community.

Soon after the young queen has entered upon her duties as mother of the hive, the day comes for the murder of the drones. Their life has been a short and a merry one. They have been reared and fed and housed for one purpose, and one only, namely, that the strongest and swiftest may overtake a princess in her flight and mate with her. Once the swarming is over and the remaining royal children slain, there is no longer any use for the drones. So long as there was any possibility of a young queen requiring a spouse, the drone was tolerated within the hive, but now that that work has been accomplished and summer is on the wane, the workers have no use for these lusty males, who are incapable of carrying on any of the duties of the hive. So the unhappy drones are dragged from the hive on to the alighting board, and, after biting through one wing so that they will be unable to fly, the workers cast them forth on to the ground, where they perish of cold and hunger, or are devoured by insect-eating birds. In the same way every drone larva or pupa is torn from its cells and thrown over the edge of the alighting board, so that there may be no useless mouths to fill in the lean and hungry days of late autumn and winter.

The life of the Honey Bee is linked up intimately with that of mankind, for by her labours depend very largely the amount of seed and fruit he shall harvest in the autumn. All day long, during every hour of sunshine, the Bees are flying from flower

to flower in the orchard, carrying the precious pollen to the very heart of each, that their fruit may be set. Later on they will be at work, among the white clover heads, while their big furry relations, the Bumble Bees will be doing the same duty among the large red clover. So, too, with a vast proportion of our wild and garden flowers; but for the visit of the Bees they could not set their seeds, and in a few years would become extinct. Lastly, in the honey stored in the comb, man has one of the most wholesome and nourishing food supplies.

THE STORY OF THE WASP

How doth the wicked wily Wopse
  Employ each sunlit hour?
She hides within the ripest plum
  And stings with all her power!

Yes, I am afraid that pretty well describes most people's opinion of the Wasp. But, like the majority of hasty and sweeping conclusions, it is full of error, founded on misconception and twisted half-truths. Is is the old story of "a lie which is half a lie is ever the hardest to fight." Indeed, so firmly implanted is the general belief that the Wasp spends most of her time seeking whom she may sting, that she has become symbolic of a mean and spiteful nature—"Waspish, a petulant and spiteful person: passionate: having a biting bitter speech"—to quote our dictionaries.

"Ah well," as John Henry of the B.B.C. would say, "it's all wrong!" But all the same it makes the life of the average Wasp anything but a peaceful one, and we cannot be surprised if her nerves become a bit jumpy in the presence of us humans, considering the sort of welcome she generally receives. For instance, let us suppose it is breakfast time on a sunny mid-summer morning, not the 1927 variety, but real warm sunshine, and blue sky

and all the windows open to let in the soft sun-warmed air. Father is glancing at the pages of his morning paper, while Mother is pouring out the coffee, and the children are busy with the bread and jam. All is peace and contentment, the happy prelude to the start for school and the day's work. Enter at the window a small winged insect, with slender waist and resplendent yellow and black striped body, who alights with joyful song upon the breakfast table. "Wopse," yells Charlie. "—!—!" says Father, as he lashes out with his newspaper, and very successfully knocks over his coffee on to the nice clean cloth, while Mother expostulates warmly at such language before the children, and bewails her spoiled table cloth. Peace has fled and pandemonium reigns supreme; and all because an innocent and really comparatively harmless insect came in on a friendly visit to the breakfast table. Really, I think the Wasp is quite justified if, in the general scramble, that ensues she does manage to use her sharp sting.

Now, if instead of getting excited and making a mess of our breakfast table and tempers, we had sat quiet, and tacitly permitted our unbidden guest to join in the repast, all would have been well. Indeed, an added interest would be given to our meal, for the Wasp would not have attempted to sting anyone if left to her own devices. She would soon have been far too busily engaged in collecting a share of the food on the breakfast table to worry about us. If there was any cooked meat at table, we might have watched how, with the aid of her powerful jaws, she would cut a tiny

morsel off, and then, holding it firmly, fly away out of the window. Or she might be more attracted by the dish containing the jam, and in her eagerness probably fall headlong into it, to her great vexation, for the Wasp loves to keep herself spick-and-span. Of the jam she would take her fill, and, after washing her face and legs, depart, probably to return again soon for a further supply. She is really out collecting food supplies for the hungry Wasp-babies in the nest that probably is not very far away; for Wasp-babies are fed on a mixed diet of animal food and sweet syrup, either collected from the flowers or local jam or honey pots, to say nothing of fruit pulp from over-ripe plums and pears in the orchard. Now a large part of the animal food consists of the crushed-up bodies of other insects, particularly flies; and as that great and dangerous pest to the health of our homes, the house-fly, figures largely on the menu, we have every reason to display a little friendship towards the Wasp; for any creature that preys upon the disease-carrying house-fly is doing valuable service to mankind. Indeed, were it not for the havoc caused to ripe fruit, the Wasp might be considered far more as a friend than as a foe.

Although our common Wasp is a social insect, the community does not persist from year to year like a hive of honey-bees. It is the growth of a single season, and its swarming population perishes with the first frosts of late autumn, only a few fertile queens creeping away into sheltered nooks in barns and outbuildings to spend the long

cold winter months in profound hibernation; and upon *their* survival depends the continuation of their species.

With the advent of spring the queen Wasp awakens from her deep winter sleep and crawls out into the warm sunshine. She cleans herself carefully, and for a day or two roams about exercising her wings and limbs and growing strong. Then she starts off in search of some suitable hole in the banks of the hedgerow or other likely site in which to start building operations. Not infrequently the deserted burrow of a field mouse will be selected, and from a convenient root crossing the ceiling like a miniature beam the first layer of papier mâché is attached. No wax enters into the construction of the nest or the combs of the Wasp, paper alone is the building material used throughout, which the Wasps form from fragments of plant tissue, particularly woody fibres, which they masticate with their powerful jaws, and then amalgamate by means of cement secreted by special glands, so as to make a wood-pulp that may be spread out to form the protective outer envelope, or be moulded into delicate thin-walled cells for the reception of the eggs and rearing of the larvæ or young.

Having made a papier mâché ceiling sufficiently large to cover and form the foundation, from which to carry down a cluster of four or five cells, the queen Wasp lays an egg in each, and, while waiting for these to hatch, continues cell-building operations. The eggs soon hatch, however, and then the queen

A Swarm of Bees

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Wasps Working at the Entrance to their Nest

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Wasp is kept pretty busy feeding her hungry youngsters. At first she supplies them chiefly with a sugary diet obtained from the honey nectaries of flowers or ripe fruits, but to this vegetarian dish is soon added more substantial fare consisting of insect meat. This she obtains by hunting down flies and other small insects. When she has secured her prey, the queen Wasp proceeds to bite off all the hard legs and other non-nutritious parts, the more succulent parts of the body of her victim being retained, and reduced, by means of her powerful mandibles, to a soft pulp, which the little legless maggot-like larvæ greedily devour. Directly the larvæ is full-grown, it spins a cocoon within its cell, and changes to a pupa. The whole life-history, from the laying of the egg to the emergence of the perfect winged Wasp from the cell in which it has undergone its metamorphosis, takes between three to four weeks. So soon as these first offspring have completed their development, and issued as perfect winged Wasps from their paper-walled nurseries, they at once start to assist in the general labour of the hive. For some time, all the Wasps born in the rapidly growing colony are workers or imperfect females.

The labours of the Wasps are very different to those of the honey-bee; their nest only lasts for a single season, and no attempt is made to store up food for winter use. In fact, the common Wasp (*Vespa germanica*) may be said to lead a more or less hand-to-mouth existence, food supplies being brought in daily for the feeding of the larvæ; the adults

satisfying their own needs while on their foraging expeditions. But although there is no storing up of food supplies, the life of the adult Wasp is full of unceasing bustle and toil; for building operations, the extension and reconstruction of the nest and combs, are constantly going on. There is no clinging together in the semi-darkness and warmth of the hive, after a full meal, for the purpose of wax secretion, as we have seen to take place with the honey-bee when comb-building operations are in view. Each Wasp must wing forth to the nearest wooden palings, tree-trunks and other sources of supply, and there, with her powerful jaws, detach and work up into a sizeable pellet fragments of woody tissues. With the pellet held fast between her jaws she flies back to the nest, where she proceeds, with the help of her fore-legs, to press and flatten it out into a little strip or ribbon of paper, placed so as to form part of a layer of a cell-wall or of the outer covering or envelope of the nest, according to the building work that is in most urgent need, for the most varied building operations are going on simultaneously. The first beginnings of the nest consisted of some four little paper cells, like so many pouches attached to a papier mâché cover of conical form, in turn attached by a sort of paper column or footstalk, which spreads out so as to make a firm attachment to a convenient root in the roof of the burrow; and from this modest foundation it is continually being enlarged and strengthened to meet the requirements of the ever-growing community.

If we were to carefully remove the outer envelope, which is thickly coated with wasp-gum to render it watertight, we should see that the combs are laid horizontally, stage below stage, each hanging from the one immediately above it, and that they do not actually touch at their edges the walls of their envelope, sufficient space being left for the Wasps to crawl freely from tier to tier, while the mouths of the cells are directed downwards. This arrangement permits the Wasps to camp on the upper surface of the tiers of combs, snugly, during the night, or in cold, wet weather when they cannot venture abroad; for unless they can keep dry and warm they quickly perish. When a new tier of comb is to be constructed, the Wasps begin by lengthening the walls of two or three adjoining cells in the centre of the lowest comb. From these supports the first circular area of platform is drawn out, from the undersurface of which cells are built out. As each cell takes shape, and before its walls have attained their full height, an egg is deposited in it, so that no time may be lost, and in this way the new comb gradually spreads outwards in concentric rings of cells towards the outer walls of the nest. As the comb spreads, new stays or columns are let down to support the weight that is increasing with the width of the new structure. The Wasps also see to it that the expansion of the walls of their home keeps pace with the lateral growth of the new comb. They nibble away at the old envelope from within, and, if necessary, carry on fresh excavations without, removing the earth and carrying it to the surface of

the bank; and, when all is ready, attaching new paper to the outer wall of the nest, so moulding it as to leave the required space within between the edge of the comb and the inside wall. When all is finished, the surface of the Wasp's comb consists of a series of hexagons, which, although made of wasp-paper, present as beautifully symmetrical an appearance as the waxen comb of the honey-bee.

As each cell is formed the queen Wasp deposits an egg in it, not at the bottom, however, but generally to one side, and firmly glued to the cell-wall, so that it cannot fall out. The larva, on hatching, remains at first with the hind part of its body attached within the eggshell, a very necessary provision, for otherwise, owing to the vertical position of the cell, the Wasp-baby would fall out of its nursery and perish. Indeed, such an unhappy fate does befall a certain number of the Wasp-babies as they begin to grow and cast their skins. If all goes well, however, the little larva eats and grows and spins a silken lining to its cell, and finally changes therein into the quiescent pupa stage of its life, which lasts about ten days. The whole life-cycle from the depositing of the egg in the cell to the emergence of the perfect winged Wasp occupies about three weeks.

At first all the eggs deposited by the queen Wasp develop into workers, who carry on the labours of the nest, the feeding of the young, construction of the comb and gradual enlargement of the nest. But as the season advances, generally somewhere about

the first and second week in August, perfect male and female Wasps begin to appear in the nest. No elaborate royal cells are built for the upbringing of these future queens, however, nor does the old queen mother Wasp become infuriated by their presence, as is the case with the queen bee in the hive. Consequently, there is no swarming. Whether these perfect fertile females join in the general labour of the nest along with their sterile sisters appears to be doubtful; authorities are by no means unanimous on the subject. What we do know with certainty is that they mate with the males, and then, as autumn approaches, they seek sheltered nooks and crannies, out of reach of frost and damp, where they may safely spend the long, cold winter months in hibernation. Nor are the males mercilessly hunted from the nest once their function in life has been performed, but like their worker sisters they perish with the advent of autumnal cold and rain. A few weeks after the mating of the perfect females the colony languishes and becomes extinct, and, as the workers become enfeebled and unable to continue to carry out their tasks of comb-building and feeding the young, they drag the remaining larvæ out of the cells and destroy them, as if unwilling that their infant charges should perish from starvation.

As I have already stated, the common Wasp generally makes its nest in a hole in the ground in a hedgerow, or in a hollow of a tree, or other sheltered situation. Quite the most remarkable nest for size, and the most extraordinary as far as its foundation, that has come under my personal observation is the

one shown in the accompanying photographs. This remarkable nest was actually built on the end of a large brown paper parcel, containing winter curtains and some cushions, that had been stored away in a dimly lighted attic of an old country house. The queen Wasp must have found her way in through a small broken diamond pane in the ancient lattice window, and realised that in the large tightly filled brown paper parcel resting on a table, she had discovered not only a fine foundation on which to build her home, but also a practically inexhaustible supply of building material on the spot. And so, throughout the long, hot days of that summer, mother Wasp and her very numerous offspring laboured undisturbed in the quiet old attic, until a nest of majestic proportions and resplendent hue arose; for not only brown paper, but fragments of red chintz curtains and varied coloured cushion covers were ground up and used in its construction. Yes, it was a noble nest and a wonderful piece of work, and I am glad to say that, after the owner of the parcel had recovered from the first shock and very natural vexation at the havoc wrought upon its contents, it was agreed that the nest and parcel should remain united, and find safe harbourage in a museum.

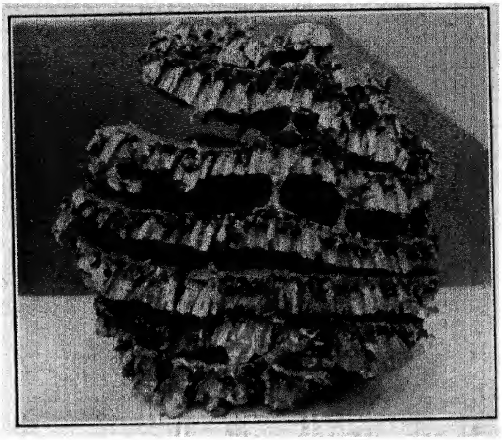
The habits of the Tree Wasp (*Vespa sylvistris*) are very similar to those of the common Wasp, save that the beautiful somewhat pear-shaped nest is attached to the bough of a tree or bush in some sheltered woodland spot, and not hidden from view under ground, and it lasts for but a single season.

Wasps never sting unless they are roused to do so by being attacked or frightened, or by interference with their work. The waving of arms or papers, and sudden movements naturally alarm them and make them cross. But if left alone, unharmed, they will remain perfectly friendly and harmless.

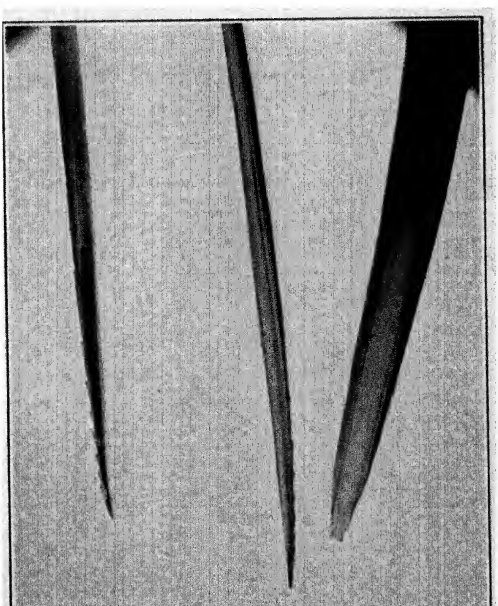
THE ROMANCE OF THE ANT

ANTS are altogether the most remarkable and the most successful members of the Insect World. We arrive at some shadowy idea of their dominance, as a group alone, when we find that so far over 5,000 species, sub-species, and varieties have been described, and still, in so far as the tropics are concerned, a vast number of species probably have yet to be discovered and placed on record. Their geographical distribution is world-wide—almost from the Poles to the Equator—amidst the last vegetation pushing its way at the snow-line on the highest mountain to the seashore; from the steaming forests of the Equator to the frozen tundras of the North, and the fringes of the arid drifting sands of the driest deserts. They have attained their unique position thanks to their remarkable longevity, their plasticity to their environment, and their relationships with other animals and with plants. Not only do they far outnumber in species all other social insects, but they have attained to a far higher, more perfect and lasting organisation.

The size of an Ant colony varies enormously in the different species, and, according to the numerical strength of its population, in its complexity. With the exception of one or two of the most degenerate and degraded forms, the colony presents the aspect



The outer walls have been removed from this nest to show the combs and supporting columns all made of wasp paper



THE BUSINESS END OF THE WASP
The sheath and slender barbs

[*Face page* 164

This wonderful nest was built on the end of a brown paper parcel containing winter curtains stored in the attic of an old country house

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of a bustling, healthy, prosperous community. But it is always a community wherein you will find no trace of those methods and ideals so dear to the heart of the Socialist and Communist. In your flourishing and perfectly organised ant community the working classes of the Ants are practically sterile; there are no trade union rules or rate of pay; each worker puts every ounce of work she can into her job from dawn to sunset, and, if need be, far into the night. The sickly, the lazy, or the physically unfit are simply pushed out or killed off, and either devoured or thrown on the rubbish heap. On the other hand, every care is taken of the eggs, larvæ and pupæ, and of the fertile females or queens, whose sole job is to serve as the mothers of the community. All are ready to sacrifice their lives at a moment's notice for the good of the community, and they are ever industrious and contented. The community consists of a large number of workers or sterile females, that frequently show considerable variation in size, according to the duties they may have to perform; of one or more fertile females, the mothers of the community, and, at certain seasons of the year, young virgin females and males that will ultimately quit the nest, pair, and become the founders of new colonies.

In most species of Ants the perfect female, as in the case of the queen bee, indulges in a single nuptial flight; but, whereas the queen bee mates with only one male or drone bee, the queen ant pairs with several males in rapid succession, and as the result remains fertile throughout her long life which may last for

fourteen or fifteen years, if not longer. After mating is completed, the queen Ant comes to the ground, rubs or tears off her wings, and becomes the mother of a colony. The male may live for a few days or weeks after pairing. The worker Ant, like the worker bee, is a sterile female, practically incapable of continuing her species, though occasionally she may parthenogenetically produce eggs which invariably give rise to males. It is only the queen or sexually perfect female who is capable of producing eggs, giving rise to the three classes, namely sterile females or workers, fertile females or queens, and males. As she deposits her eggs they are immediately taken away by those workers who for the time being are acting as attendants or nursemaids, and who watch over the eggs, larvæ, and pupæ with unceasing care and devotion. A community of Ants, unlike a nest of wasps or a hive of bees, frequently contains several perfect fecundated females, and they are the mothers of all the other members of the community, and are generally surrounded by a crowd of workers who feed, clean, and protect them.

The life of the worker Ant is a relatively lengthy one, and may extend over a period of four to seven or eight years. Such a lengthy period of existence obviously affords opportunity for the repetition of experiences, and their impression, in varying degree, on the highly developed nervous system of the Ant, and is probably one of the factors which have helped to establish the Ants as quite the most intelligent members of the insect world; at once capable of learning by repeated experience, capable of judg-

ment of individual or concerted action, and yet, under certain conditions of displaying the most abject automatism. Ants have the sense of taste highly developed, and are particularly partial to honey, to the nectar and sweetish juices of plants, which they obtain by their own exertions or through the agency of Aphids and other insects that feed by sucking the sap of plants. The power of vision varies enormously in the different species, for while some appear to have relatively good sight, others are totally blind, depending solely upon their wonderful sense of smell and touch. The Ant's nose is situated in its antennæ, the organs of smell consisting of highly specialised microscopic hairs whose base connect with the termination of the olfactory nerve-endings. These exquisitely sensitive organs, called by Forel the topochemical organs, are especially abundant on the mobile, club-shaped tips of the antennæ, and are so delicately perceptive that they actually convey to the Ant a knowledge of the topography of the places surrounding it, by the detection of their odours. For purposes of offence and defence the Ant is equipped with poison glands, and frequently, though not in all species, with a sting.

For purposes of classification the Ants have been divided into five sub-families: i. the *Ponerinæ* comprising seven tribes and including the most primitive and archaic forms; ii. the Sub-family *Dorylinæ*, with three tribes, and including those Huns and Tartars of the insect world, the Driver and Legionary Ants ; iii. the *Myrmicinæ* divided into nine tribes

and including among its species the Fire-ants (*Solenopsidii*), the true Harvesting Ants and the Fungus-growing Ants; iv. the Sub-family *Dolichoderinæ*, with numerous species having a cosmopolitan range, and in which the remarkable anal glands, secreting an irritant and highly aromatic product, are nearly always present, the secretion from these glands replacing to a greater or lesser degree the function of sting and poison gland. These repugnatorial, or anal, glands, were discovered by Forel, and consist of grape-like clusters of large, spherical gland-cells, their secretion having a very characteristic odour, called by Forel the "Tapinoma odour," as being common to the species of this genus in Europe and North America. Other workers have less euphonistically likened the smell to that of rotten coconuts.

When fighting with other Ants the *Dolichoderinæ* endeavour to smear the secretion from their anal glands on to the bodies of their foes, and from the instant response and subsequent behaviour of the enemy it is evident that the liquid is fatal, or of so irritant a character as to constitute a most efficient protection; Sub-family v. the *Camponotinæ*, is divided into six tribes, and includes such well-known cosmopolitan species as our Garden and Meadow Ants (*Lasius*), and the Wood Ants (*Formica*), and the Slave-makers (*Polyergus*, *Camponotus*).

Almost as ubiquitous as the Ants are the Aphids or Plant-lice (*Homoptera*), and from the close and apparently cordial relationships existing between

them, the Aphids have been very appropriately designated the flocks and herds of the Ant world, for they play a very important part in the economy of the Ants, supplying the bulk of the food of their hosts. Small wonder that we find in those species of Ants whose principal food consists of the sweet juices of plants, the most tender regard and solicitude for these soft-bodied, comparatively defenceless creatures. Long and careful observation, coupled with repeated experiment, has established beyond all doubt the intimate relations existing between these two groups of insects. This does not mean that the habit is universal, for the purely Carnivorous Ants pay no attention to the Aphids, while the Harvesting Ants and the Fungus-growing Ants have little or but a casual regard for them. In the same way, we find that all species of Aphids do not welcome the attentions of the Ants, the more active and solitary of habit resenting their approach, while the sedentary and the root-feeding species exhibit pleasure and satisfaction.

Aphids obtain their fluid food by inserting their long slender proboscis into the tissues of the plant and sucking up the watery fluid containing in solution cane sugar, invert sugar dextrine, and traces of albuminous substances. This passes through the alimentary tract of the insect, a relatively small amount of all the substances being assimilated in the process, and it is ultimately voided by the anus in colourless drops, which, when falling on the leaves of the plant and drying in the air, forms a sweet, sticky coating popularly called "honey-dew."

The quantity of honey-dew voided by these small insects is truly remarkable, a single individual voiding from nineteen to forty-eight large drops of the fluid in the course of twenty-four hours. Small wonder that succulent plants in our gardens and fields, if heavily infested by Aphids, quickly become exhausted during a spell of dry weather. When unattended by Ants, the Aphid, by a jerk of its body, expels the drop of fluid to some distance, but when solicited by its friend, allows it to issue more slowly, so as to give the Ant time to imbibe it.

When desirous of obtaining a supply of honey-dew, the Ant approaches the Aphid and proceeds with its antennæ gently to stroke the Aphid's abdomen, using first one antenna and then the other. The Aphid, if not already milked dry by a previous visitor, quickly responds, and with lowered head and raised body slowly voids a drop of the coveted honey-dew. The Ant then proceeds to visit a second, third, fourth, or even more Aphids, soliciting and imbibing from each a drop of the precious fluid, until, replete, and with distended body, it returns to the nest, where it will at once proceed, at the request of some of the inmates, to share the spoil, regurgitating a small drop at a time to each hungry comrade, who gently taps and strokes with its antennæ her head and face.

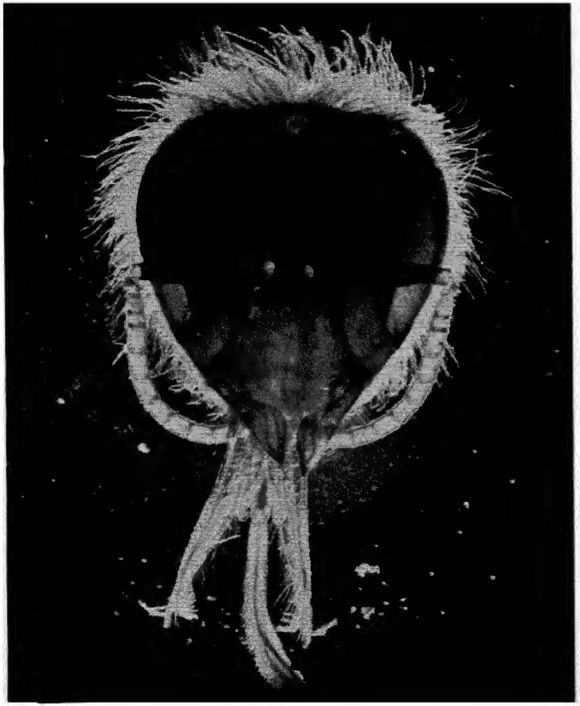
In some species of Aphids two slender tubes, one on each side, on the base of the abdomen, are to be seen, and for a long time it was thought that

it was the fluid discharged from these tubes that constituted the honey-dew so eagerly sought by the Ants. More careful observation, however, has clearly demonstrated that this is not the case, the fluid secreted from these tubes being quite different in composition, and intended for quite a different purpose, namely as an offensive weapon against the Aphid's foes. When the larva of a Lace-wing Fly or the larva of a Ladybird Beetle, both of which feed on the bodies of these insects, misses its first stroke, or only obtains a partial hold upon its victim, the unfortunate Aphid twists and turns and endeavours to discharge the fluid from its tubes, or cornicules as they are termed, on to the face and head of its foe. The secretion, which is of a sticky, wax-like character, immediately hardens, and thus forms a most uncomfortable coating, causing the enemy to desist from his attack until he has had time to rid his jaws and head from it. Further, it is interesting to note that these tubes are most highly developed in those species of Aphids which live singly and not in masses or colonies, and are not attended by Ants; while they may be vestigial or completely absent in those species habitually cared for or living within the nests of the Ants.

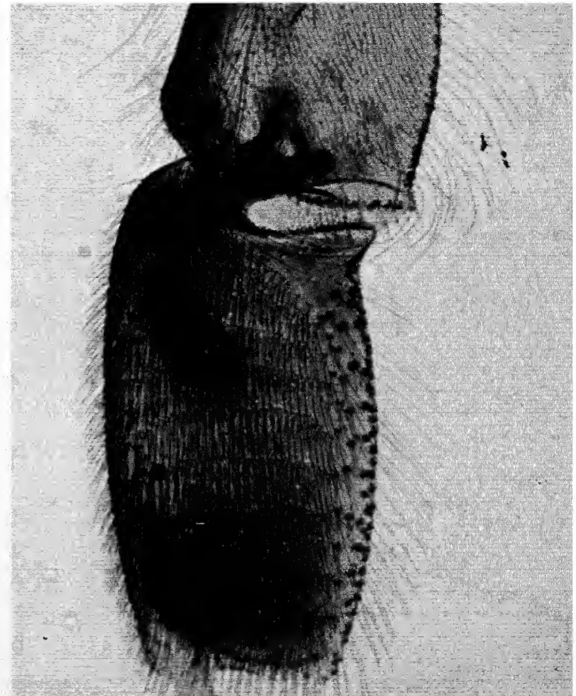
Various species of our British woodland, field, and garden Ants regularly visit Aphids, or actually harbour them within their nests. Rather more than forty species of Aphids up to the present have been recorded from the nests of British Ants alone.

It was the late Lord Avebury (better known to the public, perhaps, as Sir John Lubbock) who first proved that the eggs of Aphids were actually carried by the Ants into their nests, and there carefully tended and guarded throughout the winter. Then in early March, on the return of spring and the hatching of the young Aphids, the Ants carried them forth and placed them low down on the young shoots of daisies, the natural food plant of their little charges, and built up a protecting wall of earth round and over them. These observations were made by Lord Avebury on our little common garden and meadow Ant, *Lasius flavus*. By this care in keeping during the six months of winter these Aphid eggs, which are of no direct use to them during that period, the Ants preserve the material from which they will have the certain means of procuring an abundant food supply throughout the following summer. Surely we have here, as Lord Avebury justly remarks, "a case of prudence unexampled in the animal kingdom."

But Aphids are not the only insects to be found more or less intimately associated with Ants in their nests. Certain species of beetles, wasps, bugs, flies, crickets and cockroaches, butterflies and moths and thrips during the larval or adult stage of their lives frequent the nests of Ants as unbidden guests; as do also certain mites, spiders and woodlice. A motley assemblage, of which something approaching 3,000 species have been recorded from all parts of the world. In their relations with the Ants, these guests may be roughly classed under three headings:



The Head of a Worker Bee



The Part of the Hind Leg of a Worker Bee
That is used for the transport of pollen to the hive

THE NEST OF THE WOODLAND WASP (*Vespa Sylvanus*)

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(1) Those that dwell in complete friendship with their hosts; the Ants not only regurgitating honey-dew to their guest but fondling it, carrying it out of danger should the nest be attacked, and also feeding and rearing its offspring; (2) Those whose presence in the nest is more or less a matter of indifference to the Ants, who pay no attention to their visitor; while the guest finds shelter within the nest, and acts as a scavenger, eating the refuse, the corpses, and even certain parasites; (3) Those insects and spiders which are abhorred by the Ants, and therefore lurk away in odd corners in or near the nest, and prey upon the Ants and their brood.

Under the first heading may be included in addition to the Aphids, the larvæ or caterpillars of certain species of Butterflies all belonging to the *Lycænidæ*, and of which our British Large Blue (*Lycæna arion*) is a classic example. For many years the life history of this handsome butterfly had puzzled entomologists. What happened to it during the later larval stages of its life, when, during August, it leaves the wild thyme, the flowers of which have so far constituted its chief food? No one had ever found the pupa; no one had ever seen a hibernating caterpillar, although the complete life-history of closely related species was well known. At last, during the years 1915–1917, thanks to the patient investigations of three well-known entomologists, Messrs. Frohawk, Chapman and Purefoy, the secret was revealed, and it was proved that this larva becomes the welcomed guest of the Ants, safely passing

the autumn and winter within the shelter of the nests of *Myrmica lævinodis* or *Myrmica scrabrinodis*, species that frequent the chalky hill-sides and such situations where the wild thyme grows.

The caterpillars of the *Lycænidæ* possess an unpaired gland in the middle of the back of the eleventh body segment, and a pair of curious short tentacles, which can be protruded, on the twelfth segment, fringed with short, stiff, feathery hairs. As this gland produces a colourless sweet liquid, we have the reason for these caterpillars being eagerly sought for, and protected by the Ants. The association is of mutual benefit, a true symbiosis. Now in August, when the caterpillar of the Large Blue Butterfly leaves the thyme, on the flowers of which it has been feeding, it wanders about on the ground until it is met by a foraging Ant who is almost certain to run up to it at once. The Ant may communicate the discovery to its fellow workers, who become equally excited, or it may at once proceed to "milk" the larva, gently stroking the caterpillar's hind body segments with its antennæ to induce the caterpillar to exude a drop of the sweet fluid from her special gland, and which the Ant eagerly sucks up. This over, the Ant walks round the caterpillar as if to admire its new-found "cow." Some form of communication then appears to take place between the two insects, for the caterpillar retracts its head, and hunches its thorax up in a curious way, then the Ant promptly seizes it by the thorax and carries it off into her nest. Here, although occasionally milked, the cater-

pillar does not appear to attract particular attention; it wanders about, and finds out the best stocked nursery chambers, and, resting quietly therein, devours a large number of the Ants' larvæ, and grows fairly rapidly. In the following spring it spins up and pupates in one of the galleries of the nest, and emerges as a perfect butterfly in June, having spent about ten months of its life as a sheltered guest of the Ants.

By far the most dominant guests of the Ants, both as regards species and numbers, are the Coleoptera or Beetles. Some being true guests, others coming under Headings 2 and 3. Five species of true guest beetles are found within the nests of British Ants. As might be expected, the bodies of these beetles have become more or less modified to meet the requirements of their method of life, particularly the mouth-parts of those species which are fed by their hosts, and their antennæ are also modified for better communication when soliciting food, and even to serve as convenient handles by which the Ants can hold and transport them. Those true guest beetles that supply their hosts with sweet secretions and are therefore particularly treasured by the Ants, are furnished with tufts of red, brownish-red, or golden-yellow hairs or bristles, known as *trichomes*, situated on various parts of the body, frequently at the sides and near the base of the wing-cases or on the antennæ. They generally cover the pores or openings of the unicellular glands producing the sweet secretion, and appear to be very sensitive and responsive, for the eager licking of

these trichomes by the Ants at once causes a flow of the secretion.

We may well take as our first example of these interesting guests the little blind Beetle, *Claviger testaceous*, first discovered and described by Preyssler, in Bohemia, so far back as the year 1790, but whose complete life-history has never been worked out, though adults have been kept in observative Ants' nests for many years, where they have been seen to pair. Nevertheless, the larva is still unknown. This beetle is a frequent guest in the nests of the yellow and black field and garden Ants, *Lasius flavus* and *L. niger*, sometimes occurring singly, or perhaps half a dozen, but not infrequently in large numbers, seventy and one hundred having been recorded from single nests by one observer. The beetle appears to be present throughout the year, and although actually capable of feeding itself, having been observed to devour both eggs and larvæ of its host, it appears to prefer to be fed by the Ants, who habitually supply it with nourishment as they do one another.

After feeding a Claviger beetle, an Ant will pick it up by its thorax and carry it away. It will, on placing the beetle on the ground, proceed to lick vigorously the tufts of hairs or trichomes at the base of the wing cases, soon with every sign of pleasure, and may finally give its guest a sort of general wash-and-brush-up, licking the whole of the upper surface of its body. The little Claviger beetle is very fond of clinging to the undersurface of the abdomen of the Ants, and, by attaching itself to

the virgin queens when they quit the nest on their nuptial flight, gains establishment in the new nests.

Our next example of a true guest is a little beetle called *Atemeles emarginatus* and is of peculiar interest as it is double hosted, spending the summer months in the nests of the Ants of the genus *Formica*, and the winter months in the nests of the genus *Myrmica*. The Atemeles are carefully tended, cleaned and fed, and carried about by the Ants, who may also be seen frequently licking the tufts of hairs covering the trichome glands which in Atemeles are situated on the sides of the long and flexible abdomen. When this remarkable beetle desires a meal, it walks up to an Ant and not only communicates its wants by tapping with its antennæ, but further imitates the actions of a food-soliciting Ant by gently stroking the side of its host's head with its front foot. Although the Atemeles would appear to derive the bulk of its nourishment in this way, it is quite capable of feeding itself, and, in fact, does devour dead flies or caterpillars that have been brought into the nest, as well as the larvæ of its hosts.

The Atemeles spends the late autumn and the whole of the winter comfortably lodged in the nest of its Myrmica hosts, who devote much time to its care, cleaning and feeding it, carrying it from one part of the nest to another as occasion may require, and licking its trichomes with the greatest satisfaction and delight. With the return of spring, however, the Atemeles grows restless, and departs from the Myrmica nest to spend a few days or a week in the open air. This is not exactly a holiday, but

really a period of quarantine to enable the beetle to cleanse itself from the odour of the Myrmica nest which would arouse the wrath and suspicion of its future hosts. The short period of quarantine over, the Atemeles enters into its summer quarters inside a Formica nest, where it is made just as welcome, and is just as kindly treated. Here, if it is a female, the Atemeles deposits her eggs on the egg-masses of the Ants, and her offspring hatch out very quickly and devour goodly numbers of the Ants' eggs. But the Ants do not appear to resent this in the least, displaying the greatest affection for the Atemeles larvæ which somewhat resemble their own in general shape; carrying them to safety at the least sign of danger, feeding them by mouth, cleaning them, and last but not least, placing them among their own larvæ, of which the guest babies devour large numbers. When these young criminals are ready to pupate, the Ants help them by partially covering them with particles of earth and other debris (just as they do for their own offspring), and this material the beetle larvæ spin together. And now comes nemesis for many; in fact only those who have managed to pupate in some obscure corner unobserved, or have been forgotten will survive and complete their metamorphosis. The Ants are in the habit of constantly handling their own pupæ, and often help the adult Ant to free itself from the pupal skin. They apply the same methods to their guests with fatal results, repeatedly digging them up and generally disturbing them, which, in the case of the beetle larvæ, prevents pupation taking

place, and causes their untimely death—they are, in fact, killed by kindness.

However, some live to complete their metamorphosis, and these and the old adult Atemeles quit the Formica nests, and in this case after a very much longer period of quarantine, about the first weeks of September, begin to seek out and take up their abode in a convenient Myrmica nest for the winter.

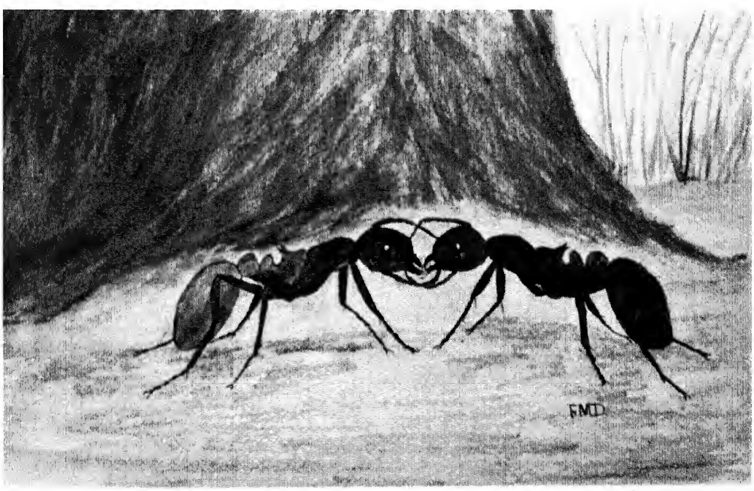
Unlike its nearest allies, which we have just been considering, our next example, *Lomechusa strumosa*, lives its whole life with one species of Ant, our well-known Red Ant (*Formica sanguinea*). This beetle is normally viviparous, bringing its young larvæ direct into the world, and they are well cared-for by the Ants, who clean them, feed them by mouth, carry them from one part of the nest to another, and place them among their own larvæ, large numbers of which the Lomechusa larvæ devour. The adult beetle is especially attractive to its hosts, and receives much attention. Its numbers are kept in check by the Ants' digging up its pupæ and carrying them about, which has the same fatal results as with Atemeles.

As examples of the second group of guests, namely those who live unnoticed by the Ants, and in return for safe lodging may act as housemaids and scavengers, we will take a little moth, a small handsome fly and a very diminutive Ant. The little moth frequents the nests of the Wood Ant (*Formica rufa*) spending its whole life either within the nests or resting on herbage in their immediate neighbour-

hood. This small moth—its spread of wing is less than one inch from tip to tip—is the possessor of a very long scientific name, *Myrmecozela ochraceella*. It has a slender body and delicate narrow wings, and is of a general pale yellow-ochre colour. It is to be found during June and July resting on the grass stems, and leaves near the nests of the Wood Ants, or actually on the surface of them. When about to lay her eggs, the little moth calmly enters one of the openings in the nest, and quietly deposits her eggs in one of the galleries. She is in no way molested by the Ants, who, indeed, seem a little frightened of her, and glad to keep at a respectful distance. Possibly they fear their antennæ being fouled by scales from her wings or body becoming attached to those delicate organs, if they stroked her in friendly greeting as they do the Atemeles and Lomechusa beetles. The caterpillars of Myrmecozela are whitish, with dark heads, and throughout this stage of their life-history make long tubes composed of fragments of leaves, earth, pine-needles, and twigs fastened together with silk; and it is upon the vegetable debris of the Ant's nest so collected, that they feed. In this state they pass through the autumn, winter and early spring, when they change to pupæ within the protecting walls of their tubes, and the perfect moth escapes during the month of June.

During the summer months a handsome, small fly called *Microdon*, and somewhat resembling a miniature humble-bee in appearance, may be found resting low down near the ground on the stems of

A WORKER ANT FEEDING A LOMECHUSA BEETLE



ANT ABOUT TO FEED A FELLOW-WORKER WITH HONEYDEW FROM HER CROP

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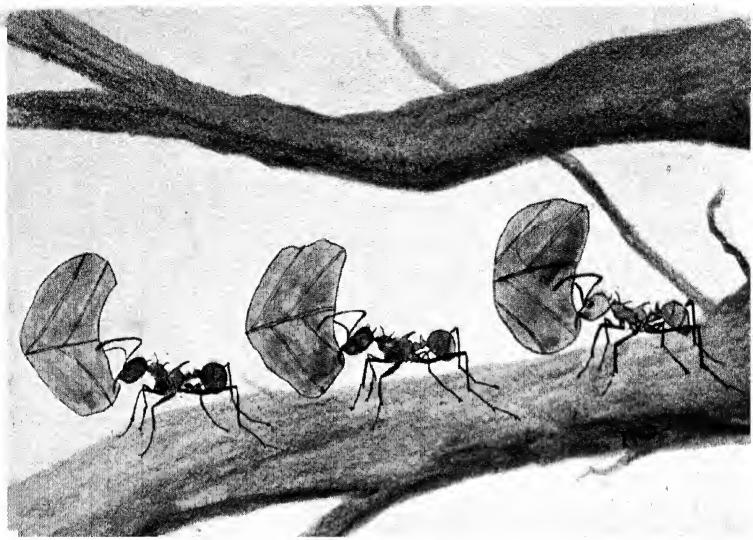
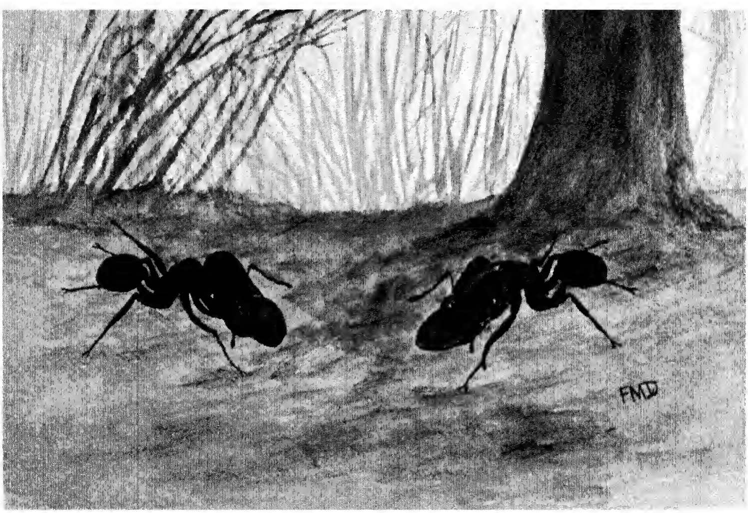


Leaf Cutting Ants Returning to their Nest



Harvesting Ants Returning with Seeds to their Nest

grasses and other plants in the vicinity of Ants' nests. It is the larva of Microdon, however, who is the unbidden, almost unnoticed guest of the Ants. It is a strange looking little creature not in the least like an ordinary insect larva, and is a dirty white in colour, oval and convex in shape, and has a curious flat, creeping-sole surrounded by a fringe of hairs. In fact so slug-like is the little Microdon larva in appearance and movements, that it and most of its related species when first discovered, were described as belonging to the *Mollusca*. By means of its creeping-sole the little Microdon larva wanders about in the interior of the nest, where it appears to feed entirely upon the pellets ejected from their infrabucal pockets by the Ants; in fact, it plays the part of an humble scavenger within the nest, though some of the South American species are said to prey upon their hosts' pet scale-insects. Several Microdon larvæ will often be found resting together in one of the chambers of their host, and it has been observed that when, for some reason, the Ants cease to frequent a particular chamber, then the Microdon larva will also depart therefrom, slowly creeping after its hosts. The Ants run over and even sit on the Microdon larva, without apparently taking the least notice of it; probably because its upper surface is well protected by a very tough skin. All is well so long as the strange little creature keeps right side up, but should it, in the course of its perambulations, have the misfortune to fall over on its back, then the Ants will attack it, and, biting through the thinner abdominal

skin, kill and devour it. The young Microdon larvæ live deep in the nest during the autumn and winter, and then in early spring, as the time draws near for them to pupate, they come up into the chambers nearer the surface of the nest. In the process of pupation, the larva remains quiescent, firmly fixed on its creeping-sole; it slightly contracts, and the skin changes to a reddish brown and becomes hard and brittle; and two or three days later two little horn-like tubercles connected with the breathing of the pupa can be seen projecting in front. This stationary pupa-stage lasts between three or four weeks when the perfect insect emerges, usually at night, when all is comparatively quiet within the nest, and as soon as its body has dried and its wings expanded, makes its escape into the open air. When the fertile female Microdon approaches the neighbourhood of an Ants' nest during May and June for the purpose of laying her eggs the Ants will endeavour to chase her away, but sooner or later she accomplishes her purpose.

Although, as a general rule, among the Ants each species lives by itself and will resent the approach of individuals from a nest belonging to another species, there are, however, some interesting exceptions. Such is the case with the tiny little ant called *Stenamma westwoodii* which lives almost exclusively in the nests of our large Wood Ant (*Formica rufa*). The relations between the two species appear to be of a perfectly amicable character, though whether they are of any direct service to each other

beyond the large and formidable Wood Ant affording protection and shelter to their diminutive guest, it is hard to say. Certain it is, however, that whenever the Wood Ants change their quarters for a new nest the little Stenammas always accompany them, and it is very amusing to see these wee creatures on the march running between the legs of their relatively big hosts, tapping them inquiringly with their antennæ as if to find out what all the fuss is about, and even mounting on to their backs for a short ride, while the sturdy Wood Ants take but little notice of them.

Very different is the condition governing the presence of another small Ant that dwells in the walls of the nest of its larger host, excavating its own chambers and galleries therein; and will serve to introduce us to the third heading, namely uninvited and abhorred guests. This small Ant, *Solenopsis fugax*, is really a social parasite, and is the bitter enemy of its hosts, who are always ready to slay any individuals that cross their path, but who, on account of their size, cannot enter the galleries of their relentless though diminutive foes. Therefore the little Solenopsis build their galleries in the walls and live there in safety, making raids upon the nurseries of the larger host, and carrying off the larva and eggs for food. Indeed, as Lord Avebury said, "it is as if we had small dwarfs, about eighteen inches to two feet long, harbouring in the walls of our houses, and every now and then carrying off some of our children into their horrid dens."

To this same class of hostile guests belong a

number of small, narrow-bodied beetles related to the so-called Devil's Coach-horse Beetle (*Staphylinidæ*) and belonging to the genus *Myrmedonia*. All are to be found lurking in out-of-the-way corners of the nest, or hidden near the paths leading from the nest, where they lie in wait to pounce upon and murder solitary individuals. When attacked or disturbed, they will curl up and feign death, remaining absolutely motionless for a considerable time, or they will discharge from their anal glands a vapour possessing a strong and pungent smell, which seems to have a paralysing effect upon their antagonists. Mr. H. St. J. K. Donisthorpe, who has devoted so much attention to the different classes of guests to be found in the nests of our British Ants, describes how he has seen Ants seize one of these Myrmedonia Beetles, but obliged to relinquish their hold and to wander about in a dazed condition, after a discharge of this vapour or gas, while the beetle calmly departed into the nest. In his account of *Myrmedonia humeralis*, an unwelcome guest in the nest of the Wood Ant (*Formica rufa*), Mr. Donisthorpe writes—"A cart-track ran through the wood passing near one large *rufa* nest, and in this track *Myrmedonia humeralis* was seen in every crack and under every dead leaf. Here and there little heaps of dead ants were to be found, and these were continually increased by further victims of the Myrmedonias. The beetles could be seen lurking, and then suddenly pouncing on solitary ants, of which thousands must have been killed in this way."

A very remarkable adaptation of bodily structure which has resulted apparently from the relations of Ants to plants, and perhaps more particularly to Aphids, is that of the Honey Ants. Many Ants are in the habit of collecting nectar and honey-dew, which they store in their distensible crops until they return home to the nest where they part with the bulk of it by regurgitation to their larvæ and sister ants. It is possible now to trace the gradual development arising from this habit, in the gradually increasing size and elasticity of crop and abdomen, until we reach those special workers of the Honey Ants, which have literally become living honey-pots. Species of these remarkable Ants have now been found in Africa, Australia and North America, all chiefly dwelling on the fringe of hot, arid regions. The best known of these is the North American Honey Ant (*Myrmecocystus horti-deorum*), whose habits have been very carefully observed by McCook and Wheeler. These ants dwell in the deserts and dry plains from the City of Mexico to Denver, Colorado, and make their nests in the hard soil, driving shafts to some depth, and excavating chambers having smooth flattened floors and vaulted rough-surfaced ceilings. From the ceilings of these chambers hang the curious workers whose bodies are distended into miniature balloons, owing to the extraordinary development and distension of their crops. They never quit the precincts of the nest, and are capable of a certain amount of movement, though, should one fall to the ground, it is incapable of regaining its position on the ceiling without help

from the active, foraging workers; and are literally living honey-pots, containing the reserve food-supply of the nest. In the evening the ordinary worker ants sally forth in search of nectar and honey-dew, which they collect partly from the exudations from the surface of small galls formed on the twigs of the Scrub Oak (*Quercus undulata*), partly from the Aphids and scale-insects living on the surrounding vegetation. These supplies are brought back by the ordinary workers to the nest and immediately regurgitated down the throats of their honey-pot sisters until their crops are expanded and filled to repletion. Thus when in the heat of midsummer everything becomes baked and parched, the Ants have acquired a valuable reserve of food upon which to draw, and have only to solicit their rotund sisters by gently tapping and stroking their heads with their antennæ to receive a portion, and as there may be three or four hundred of these living honey-vats in a fair-sized nest, there is little fear of a shortage of food over what is a normal summer drought for those arid regions.

A somewhat similar environment would appear to have played its part in moulding the habits of the Harvesting Ants which are to be found in the warmer parts of both the Old and New World. In fact it was this marked habit of collecting and storing grain which attracted the attention of Solomon and the early Greek and Roman philosophers to the Harvesting Ants of the Old World. Do we not all know the admonition of Solomon:

> "Go to the Ant, thou sluggard; consider her ways and be wise:
> Which having no guide, overseer or ruler,
> Provideth her meat in the summer, and gathereth her food in the harvest."

and again:

> "There are four things that are little upon the earth, but they are exceeding wise:
> The ants are a people not strong, yet they prepare their meat in the summer."

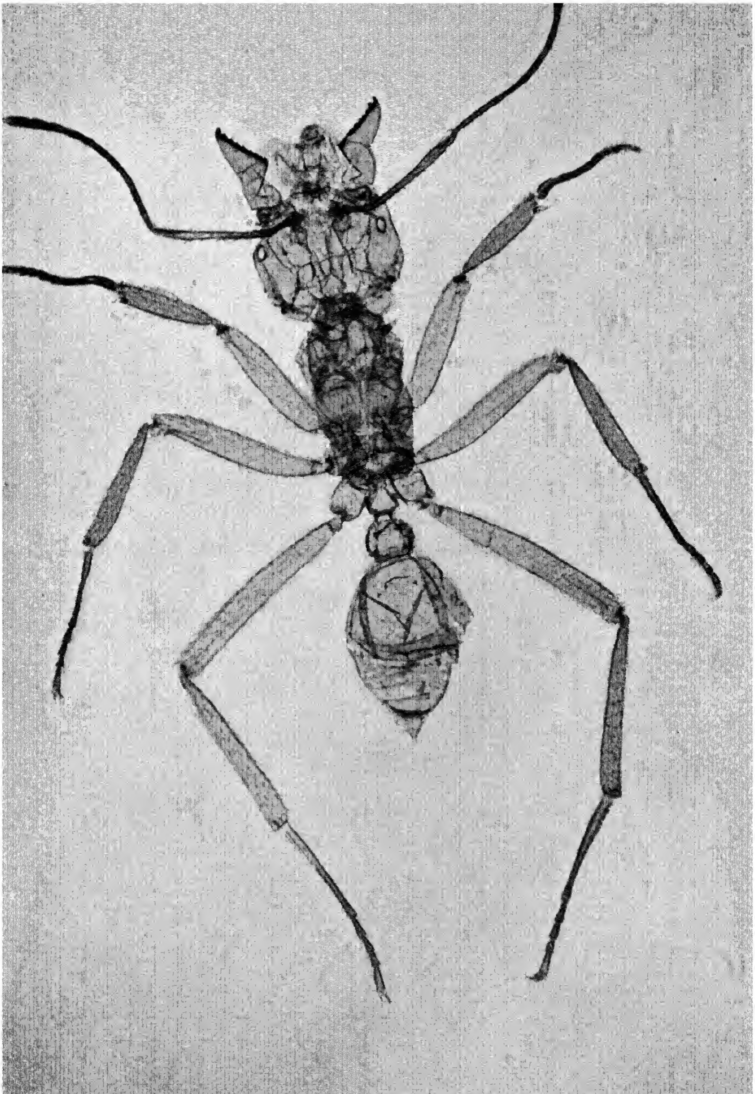
Virgil in his Æneid compares the Trojans hasting their departure to Harvesting Ants; Dryden's translation of the passage reading as follows:

> "Thus in battalia march embodied ants,
> Fearful of winter, and of future wants,
> T'invade the corn and to their cells convey
> The plundered forage of their yellow prey.
> The sable troops, along the narrow tracks,
> Scarce bear the weighty burden on their backs;
> Some set their shoulders to the ponderous grain;
> Some guard the spoil; some lash the lagging train;
> All ply their several tasks, and equal toil sustain."

Many of these early records gave an extraordinarily accurate account of the Harvesting Ants, but were apt to convey the impression that the habit of storing grain was universal among Ants, and not, as is really the case, confined strictly to a very limited number of species; and this looseness of statement led up to a very curious position during the latter part of the eighteenth and the early years of the nineteenth century. As the Northern development

of learning and science progressed, those scientific workers who were devoting particular attention to the habits of Ants soon discovered that so far as England and Northern Europe were concerned the true Harvesting Ant was non-existent, and, as later investigation of the Ant fauna of the Mediterranean Region and the Tropics has fully established, they proceeded a little too hastily to reject the statements of the Classic authors as being altogether untrue and fabulous.

Of the habits of the Southern European Harvesting Ant (*Atta barbara*) which is abundant on the Riviera, Mr. J. T. Moggridge made a searching investigation during the autumn, winter and spring of 1871–1872, by which he was able to establish fully the fact that large quantities of the seeds of different plants were collected, husked, and stored in special chambers by these Ants. When collecting seeds a double line of ants could be traced for a distance of twenty-four yards, coming and going between the nest and the harvest ground, while hundreds more would be dispersed among the seeding plants or employed at home in sorting out the collected material and attending to the internal economy of the nest. The stream of returning ants would be heavily laden, carrying not only seeds of large size and fallen grain, but also green seed pods and capsules, the torn stalks of which plainly showed that they had been hastily gathered from the plant stems by the Ants. Though the majority of the incoming workers were bearing seeds in some form to the nest, occasionally one or two might be seen carrying a dead insect, or crushed



A LEAF CUTTING ANT
As seen under the miscroscope showing the powerful serrated jaws

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ANT SQUIRTING POISON TO BRING DOWN A CATERPILLAR

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land-shell, the corolla of a flower, a fragment of stick, or a leaf. Occasionally an ant who had obviously made a bad selection would be plainly told, on its return, that it had brought home with such pains what was no better than rubbish, and would be hustled out of the nest and made to throw its burden away.

Neither *Atta barbara* nor *Atta structor* employ any materials in the construction of their nest, but simply excavate it out of the earth itself, or, occasionally, out of the sandy rock. The large mounds, which in great part are composed of plant debris, frequently to be found at the entrance to their nests are really the rubbish heaps and kitchen middens, built up of the grains of earth and sand brought to the surface by the Ants in the process of excavating the underground galleries and chambers of the nest, but principally of seed-husks and other plant refuse. While an army of workers are employed in seeking and bringing in supplies of grain, others are busy sorting out the materials thus obtained, stripping off all useless coats and husks, and carrying them outside the nest to throw away. In this manner, during the height of the harvesting season, the mound increases rapidly in size. By what means the Ants prevent germination of their large stores of seed has yet to be discovered. The chambers in which the seeds are stored are at varying depths, with concave ceilings, and the floor (in *Atta barbara*) apparently specially made of sand grains more or less cemented together. Seeds stored in these chambers, though quite moist, show no trace of

germination. After heavy rains, the Ants will bring their stores of grain out on to the surface of the nest to dry in the sun, and it will then be seen that in any seeds which may have started to germinate further growth has been checked by the Ants having gnawed through the radicale or first root growth of the seed. Such seeds are, in effect, malted, the starch being changed into sugar, and, from the avidity with which the contents of the seeds so treated are devoured, Moggridge considered that the stored seeds when required for food were first softened, made to sprout, and malted by the Ants.

The investigations of Moggridge in Southern Europe and of Wheeler in America have clearly established the fact that although certain species of Ants do store large quantities of grain in their nests, and are by some means, at present unknown, able to retard its germination, the Ants *do not* deliberately cultivate the so-called "Ant-grass" and other plants from which their harvest is gathered, as stated by some early observers. Closer and more accurate observations of the habits of the different species of Harvesting Ants throughout the Old and New World, has proved in every case that the circlet of growing seedlings around the periphery of the nest has had its origin not by careful, systematic plantings but merely through the casting away of rejected seeds during the process of husking, and the accidental dropping and non-recovery of others by the Ants on their homeward journeys.

The Fungus-growing Ants peculiar to tropical and sub-tropical America all belong to the Myrmicine

tribe *Attii*, of which about one hundred species and sub-species and varieties have been described. The largest and most powerful species of the tribe belong to the subgenus *Atta*, and comprise the Leaf-cutting or Parasol Ants which live in great colonies in well-wooded and forest country. Unfortunately these Ants are not content to confine their depredations to the forest growth surrounding their nests, but will eagerly sally forth and quickly strip the foliage of orchard and other trees under cultivation in their vicinity. It is a truly remarkable sight to watch an army of these Ants at work, the outgoing column hurrying along to the scene of action, while in the home-coming column every member is marching along bearing a fragment of leaf between its jaws. The underground nests are often of very considerable size, and contain a number of large chambers connected by galleries. In these chambers the returning leaf-cutting workers hand over their spoils to somewhat smaller—the medium-sized workers—members who crush the leaf fragments and convert them into a suitable humus-bed for the growth of a minute white fungus, which constitutes the primary food supply of these Ants. The smallest workers of all, who only quit the nest when the entire colony moves to fresh quarters, devote themselves to keeping these veritable mushroom beds clean and free from spores of other fungi that may be brought into the nest attached to the leg and body hairs of the large leaf-collecting workers, so that the fungus growth in the chambers of a healthy, active colony is always a practically pure culture. Should the nest

be dug into and part of its contents scattered the Ants will show the greatest concern and activity in at once carrying below every fragment of their precious fungus that may have been thrown out.

When a virgin queen departs on her nuptial flight, she takes with her in her infrabucal pocket a pellet of hyphæ taken from the fungus garden of her old home. After mating, she digs a cavity in the ground, closes its opening to the outside world, and sets to work to found not only a new colony but a new mushroom bed; actually cultivating the fragments of hyphæ she has brought with her, while at the same time laying eggs and rearing her offspring.

No one can travel very far or reside for any length of time in Tropical South America without becoming painfully aware of the existence of the Fire Ant. This small and extremely pugnacious Ant is armed with a formidable sting which it uses on the slightest provocation with singularly painful effects, like red hot needles entering the skin. It is abundant throughout tropical America, and its populous nests may be made under large stones or excavated in the soil, numerous untidy, crater-like mounds being thrown up in the process.

This Ant is of interest as being partly a harvester, partly carnivorous in habit, for it will attack and devour most things that come in its way. Also it will seek out Aphids on the roots of grasses for the sake of the honey-dew secreted by these insects. It does not appear to be very fond of grass seeds, but during the summer and autumn will stock

its shallow nest chambers with quantities of carefully husked seeds of herbaceous plants such as *Croton*, *Euphorbia*, and *Plantago*. Not infrequently the Fire Ant will nest in low ground near a stream when, during the rains, inundation may take place. In the event of the nest being flooded, the ants will cling together forming a compact ball some sixteen to twenty-five cm. in diameter, with the larvæ, eggs, and pupæ placed in its centre. This animated ball is carried along on the surface of the flood, while the individual ants keep shifting their position so as to avoid too long immersion, until some projecting tree, rock or other haven of refuge presents itself on to which the entire colony hastily scrambles.

The little Fire Ant is a member of the fourth tribe, the *Solenopsidii*, of the Sub-family *Myrmicinæ* which according to Wheeler includes nine tribes, with a world-wide distribution, many of the most remarkable species, however, being confined to the warmer countries of the Old and New World; while it also includes the Harvesting Ants and the Leaf-cutting and Fungus-growing Ants.

The Driver and Legionary Ants, with their vast armies of blind yet perfectly co-operating workers, have long attracted the attention of travellers in Africa, Asia, and Tropical America. Their social instincts appear to be developed to a very high degree, for they are found dwelling together in well organised communities numbering many thousands of individuals; they make long marches in the most orderly fashion, like highly-trained troops, sweeping all before them, in their insatiable craving for car-

nivorous food and strange desire for perennial migrations.

The Driver Ants of West Africa have been studied by many naturalists. Savage, who has paid much attention to the Ants belonging to the sub-genus *Anomma*, considered that they have no permanent abode, but form a temporary nest in any conveniently sheltered situation, such as shallow depressions under the roots or fallen trunks of trees, shelving rocks and the like, in which to bivouac. Detesting full sunlight, they only make their migrations or predatory excursions on dull, cloudy days or at night. When on the march on cloudy days a temporary arch to cover the head of the advancing column is formed by the largest or soldier workers whose widely extended jaws, long slender limbs, and projecting antennæ intertwining, form a sort of net work canopy beneath which the main column passes in comfort across an open patch of ground. Should an alarm be given, the arch immediately separates into its living components who at once run about with menacing jaws in search of the foe. Once the danger is past, the living arch will reform and the column proceed on its way. Any animal unable to escape will be killed, even the large Python when lying gorged with prey may fall a victim. If, as frequently happens, they enter a house, their presence is soon made known by the sudden appearance and general movement of any rats, mice, lizards, cockroaches, and beetles that may have established themselves indoors, all frantically endeavouring to escape the onslaught of the bloodthirsty Drivers.

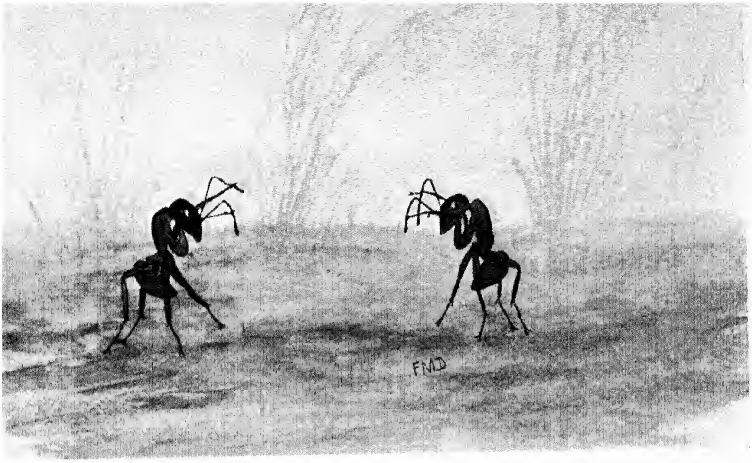
There is nothing for it, as far as the human inhabitants are concerned, but to quit the house and camp out until the Ants abandon the premises, having cleared it of all insect and animal life.

In tropical and sub-tropical America the Legionary Ants of the genera *Eciton*, of which some seventy species are known, are very similar in their habits to the Driver Ants of the Old World. Both the workers and queens usually have vestiges of eyes on the side of the head, but as they are not connected by any optic nerve to the brain, they must be useless as visual organs. All these ants have the sensory organs of their antennæ developed to an extraordinary degree of perfection, so that it is by smell and touch, Forel's topochemical reaction, that the insects find their way through the forests. There are numerous classes of workers in each colony, varying enormously in size and often in shape, and each class has its special duties to perform, the smaller generally acting as nursemaids, tending and carrying the brood when on the march, while the larger act as hunters and soldiers, using their great jaws for offence and defence.

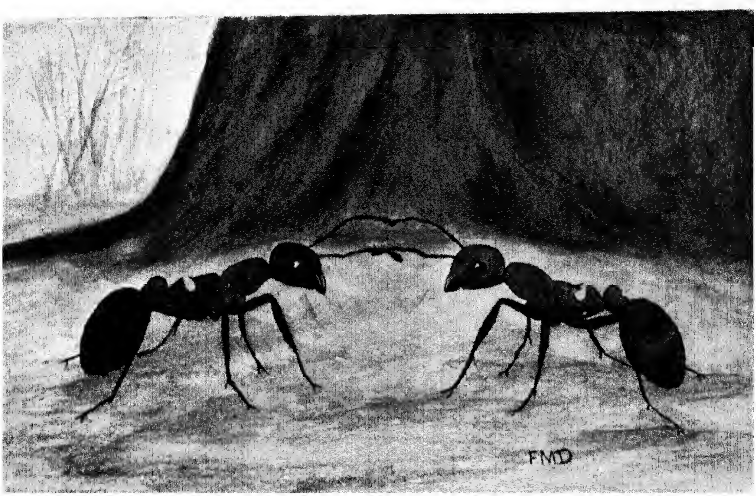
We owe much of our knowledge relating to these remarkable insects to the careful observations of the British naturalist, Thomas Belt, during his wanderings in Nicaragua. One of the smaller species (*Eciton praedator*), used, Belt states, occasionally to visit his house when they would swarm all over the floors and walls, searching every cranny, and driving out the cockroaches and spiders, many of which were caught, pulled or bitten to pieces and carried

off. He saw many large armies of this or closely allied species in the forest, his attention being generally first called to them by the twittering and movements of certain small birds that followed the ants through the woods. "On approaching to ascertain the cause of the disturbance, a dense body of ants three or four yards wide, and so numerous as to blacken the ground, would be seen moving rapidly in one direction examining every cranny and under every fallen leaf. On the flanks, and in advance of the main body, smaller columns would be pushed out. These smaller columns would generally first flush the cockroaches, grasshoppers and spiders. The pursued insects would rapidly make off, but many, in their confusion and terror, would bound right into the main body of ants. Some, however, instead of running right away, would ascend the fallen branches and remain there, while the host of ants were occupying the ground below. By and by up would come some of the ants, following every branch, and driving before them their prey to the very ends of the twigs when nothing remained for them but to leap, and they would alight in the very midst of their foes, with the result of being certainly caught and pulled to pieces. Many of the spiders would escape by hanging suspended by a thread of silk from the branches safe from the foe that swarmed both above and below."

Continuing his observations on these Legionary Ants, Belt states, "they make their temporary habitation in hollow trees, and sometimes underneath large, fallen trunks that offer suitable hollows. A



Ants at their Toilet



Ants Talk to each other by Means of their Antennæ

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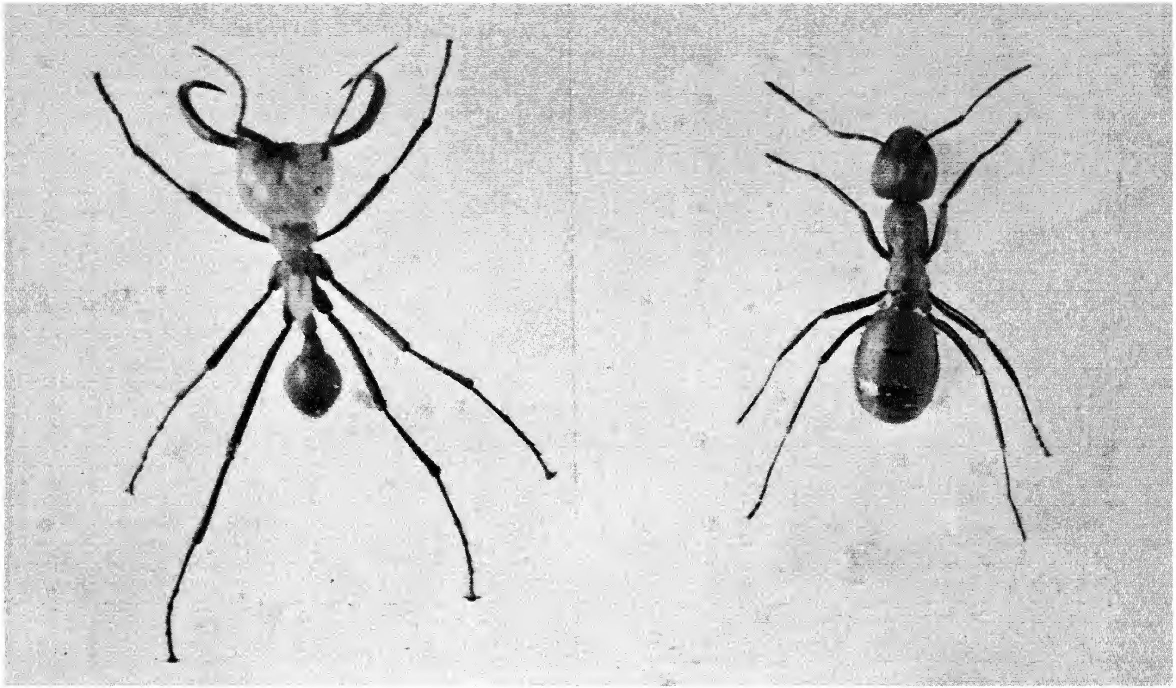

An Eciton Worker
Note the enormous jaws

A British Wood, or Red Ant (*Formica*)

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nest that I came across in the latter situation was open at one side. The ants were clustered together in a dense mass, like a great swarm of bees, hanging from the roof, but reaching to the ground below. Their innumerable long legs looked like brown threads binding together the mass, which must have been at least a cubic yard in bulk and contained hundreds of thousands of individuals, although many columns were outside, some bringing in the pupæ of ants, others the legs and dissected bodies of insects. I was surprised to see in this living nest tubular passages leading down to the centre of the mass, kept open just as if it had been formed of inorganic material. Down these holes the ants who bring the booty passed with their prey. I thrust a long stick down to the centre of the cluster and brought out clinging to it many ants holding larvæ and pupæ which were probably kept warm by the crowding together of the ants. Besides the common, dark-coloured workers and light-coloured officers, I saw there many still larger individuals with enormous jaws, and they could give a very severe bite with them, and it was difficult to withdraw the jaws from the skin."

It is these large jawed Eciton Ants which are used by the natives throughout tropical America for primitive surgery. The edges of a knife wound are drawn together, and one Eciton Ant after another is without difficulty induced to seize them in its huge jaws. The bodies of the ants are then quickly snicked off with a sharp knife, leaving their heads and their jaws firmly grasping and closing together

the edges of the wound, like a series of surgical stitches, and in every way as effective.

Slave-making is a very prevalent habit among many species of Ants, varying in intensity and reactions to a marked degree, so that we find some species quite capable of carrying on all their domestic duties and daily life without the help of slaves, while others have for so long depended upon the services of their slaves that they have become totally incapable of attending to the rearing of their offspring, or even properly feeding themselves, and in the absence of their willing servants would perish.

Our only British slave-making Ant is the handsome deep red Robber Ant (*Formica sanguinea*), which is by no means confined to England, however, having a wide geographical distribution in Europe and Asia, and is represented in North America by several sub-species. The slave-making habit would appear to be of relatively recent acquirement, as it has not had time to affect the life and character of these Ants; in fact it may be a passing phase, for it is not an absolutely standard, universal habit, there being many records of healthy populous nests of *Formica sanguinea* destitute of slaves. The favourite haunts of this Ant are clearings in pine woods, open heaths and commons and low banks bordering heathy land and pine woods. It is a very active, courageous Ant, attacking an intruder fiercely when its nest is disturbed, biting viciously and ejecting acid on to its foe. It is fond of change of quarters, and generally selects an open, sunny situation for its summer nest and a more sheltered place for the winter nest. When

moving from the winter to the summer quarters or *vice versa*, these ants transport their own and any slave larvæ and pupæ that may be present in the nest on leaving. They are fond of sporting together on or in the vicinity of their nests, pretending to fight, chasing each other, and indulging in queer antics. They would appear to be a particularly healthy, long-lived race, judging by the records of workers that have lived in observation nests for five or six years, and fertile queens for eleven to thirteen years.

When on a marauding expedition the Robber Ants advance in small troops, sending out scouts to spy out the position and movements of the enemy, and these scouts may be seen to fall into the rear and call out reinforcements from the nest to support the advancing column if necessary, or to launch a flanking attack upon the foe; their usual plan of campaign being to stampede the enemy as quickly as possible. For the knowledge of the existence of slavery among ants we are indebted to the great naturalist Huber, whose classic researches have been confirmed again and again by later investigations. Here is his account, written a hundred years ago, of a slave-making raid by the Robber, or as he called them Sanguine Ants: "At ten in the morning, a small division of the Sanguine Ants was dispatched from the garrison, and arrived in quick march, near a nest of Negro Ants, situated twenty paces distant, around which they took their station. The inhabitants, on perceiving these strangers, rushed forth in a body to attack them, and led back several

prisoners. The Sanguine Ants made no further advance; they appeared to be waiting some reinforcement. From time to time little companies of these insects came from the garrison to strengthen the brigade. They now advanced a little nearer, and seemed more willing to run the risk of a general engagement; but in proportion as they approached the Negro dwelling, the more solicitous did they seem to dispatch couriers to the garrison, who, arriving in great haste, produced considerable alarm, when another division was immediately appointed to join the army. The Sanguine Ants, although thus reinforced, evinced little or no eagerness for combat, and only alarmed the Negro Ants by their presence. The latter took up a position in front of their nest of about two feet square, where nearly their whole force was assembled to await the enemy. Frequent skirmishes take place all round the camp, the besieged always attacking the besiegers. The Negro Ants, judging from their number, announce a vigorous resistance; but, distrusting their own strength, they look to the safety of the little ones confided to their care, and in this respect show us one of the most singular traits of prudence of which the history of insects can furnish an example. Even long before success is in any way dubious they bring the pupæ from the subterranean chambers, and heap them up on the side of the nest, opposed to that where the Sanguine Army is stationed, in order to carry them off with the greater readiness should the fate of arms be against them. Their young females escape on the same side. The

danger becomes more imminent; the Sanguine Ants, sufficiently reinforced, throw themselves in the midst of the Negroes, attack them on all points, and arrive at the very gates of their city. The latter, after a brisk resistance, renounce its defence, seize upon the pupæ deposited outside and convey them to a place of safety. The Sanguine Ants pursue, and endeavour to steal from them their treasure. The whole body of Negro Ants are in flight; some pass through the enemy's ranks, and, at the hazard of their lives, enter once more their habitation, and expeditiously carry off the larvæ, that would otherwise remain devoted to pillage. The Sanguine Ants descend into the interior, take possession of the avenues, and appear to establish themselves in the devastated city. Little bands of troops continually pour in from the garrison, and begin to take away the remainder of the larvæ and pupæ, establishing an uninterrupted chain from one ant-hill to the other: thus the day passes and night comes on before they have transferred all their booty, but on the following morning, at break of day, recommences the transfer of the rest of the contents of the nest."

The tactics of the confirmed slave-making Ant *Polyergus rufescens* are very different. After preliminary investigations by scouts, the whole army will suddenly quit the nest and with all possible speed march upon their objective. Arrived at the nest that is to be pillaged, there is no preliminary hesitation or skirmishing, the Polyergus army simply pouring in a body into the nest, seizing the brood

and at once rushing out again and making for home. In the combat they kill considerable numbers of the slave species, piercing their heads and bodies with their powerful, sickle-shaped, toothless jaws. Though displaying the greatest courage and capacity for concerted action in the field, these remarkable Amazon Ants, as Wheeler terms them, are utterly incapable of fending for themselves, and are entirely dependent upon the species they enslave. Their sickle-shaped mandibles, though admirably adapted for piercing the armour of antagonists, are useless for digging in the earth, and but ill suited for the gentle handling of delicate, thin-skinned larvæ and pupæ in the narrow confines of the nest. Consequently we find that they never excavate nests or care for their young, and they are even incapable of obtaining their own food. The confirmed slave-making habit carried on through long ages and countless generations, has so modified their instincts and anatomy that for all the essentials of life, food, lodging, and the upbringing of their offspring, they are become wholly dependent on the slaves hatched from worker cocoons that they have pillaged from alien colonies.

There are other species of Ants (*Anergates*) in which the enervating influence of slavery has gone farther, until they have become weak in body and mind, few in numbers, and apparently nearing extinction, dragging out a precarious existence as the contemptible parasites of their former slaves.

And here we must bring our brief survey of the Ant and her ways to a close, trusting that within

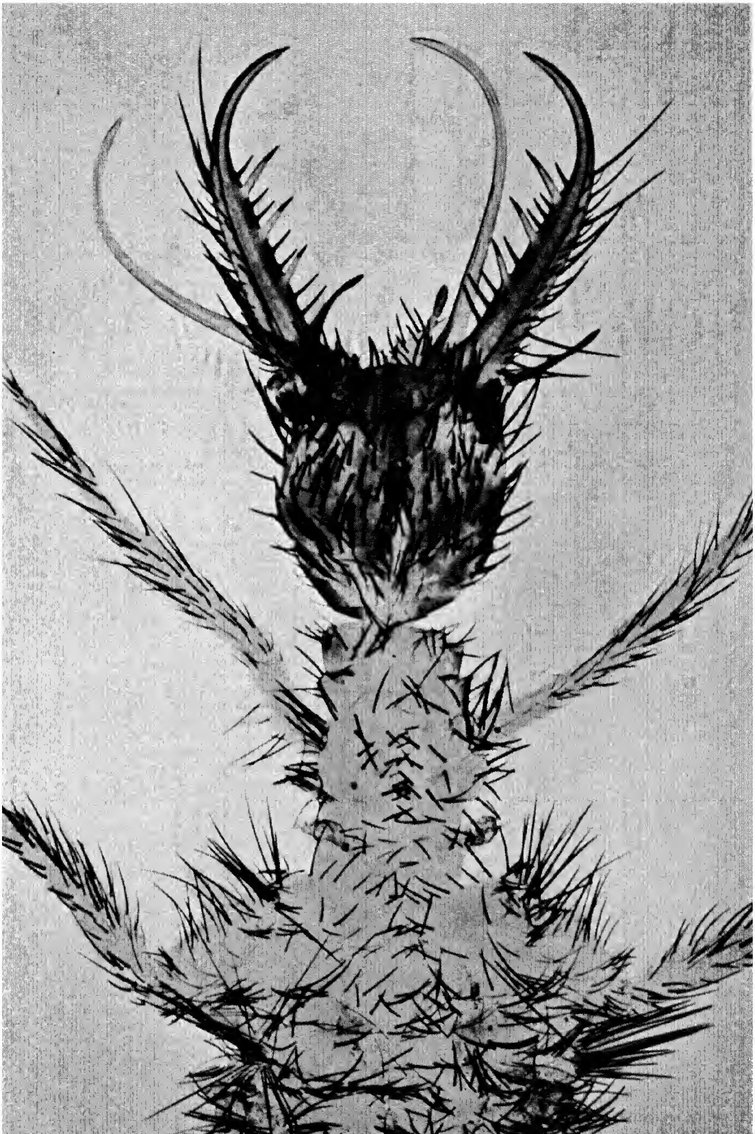
its space sufficient has been said to give some idea of the extraordinary development and specialization of habit to which this small insect has attained, and, perhaps, aroused sufficient interest to induce the reader during country rambles, should he or she meet with an Ant's nest, to pause for a few moments and at least "consider her ways."

COURTSHIP IN SPIDERLAND

I AM afraid that some of my readers may be inclined to consider Spiders as somewhat unlovely, creepy-crawly creatures, if not actually alarming and repellent. However, after reading the following account of the tragi-comedy of some of the more striking methods of courtship indulged in by these remarkable creatures, I think they should be inclined to consider the Spider in a more favourable light.

Spiders are ubiquitous creatures with a world-wide distribution, and certain species, on account of the wonderful geometrical webs which they construct, have long attracted the attention of thoughtful folk; while hoary tradition credits these geometric weavers with having saved the life of many a popular outlawed hero, by spinning a web across the entrance of the cave in which he lay concealed.

In addition to these orb-weavers, as they are termed, there are other Spiders who weave sheet-snares, or sink shafts into the ground, and line them with silk; closing the entrance to the shaft with a perfectly fitting circular door, composed of grains of earth and fragments of moss woven together with silk; while some make no web or snare at all, but hunt their prey, only using their silk-glands



In the Larval Stage, shown here, the so-called Ant-Lion Preys upon Ants

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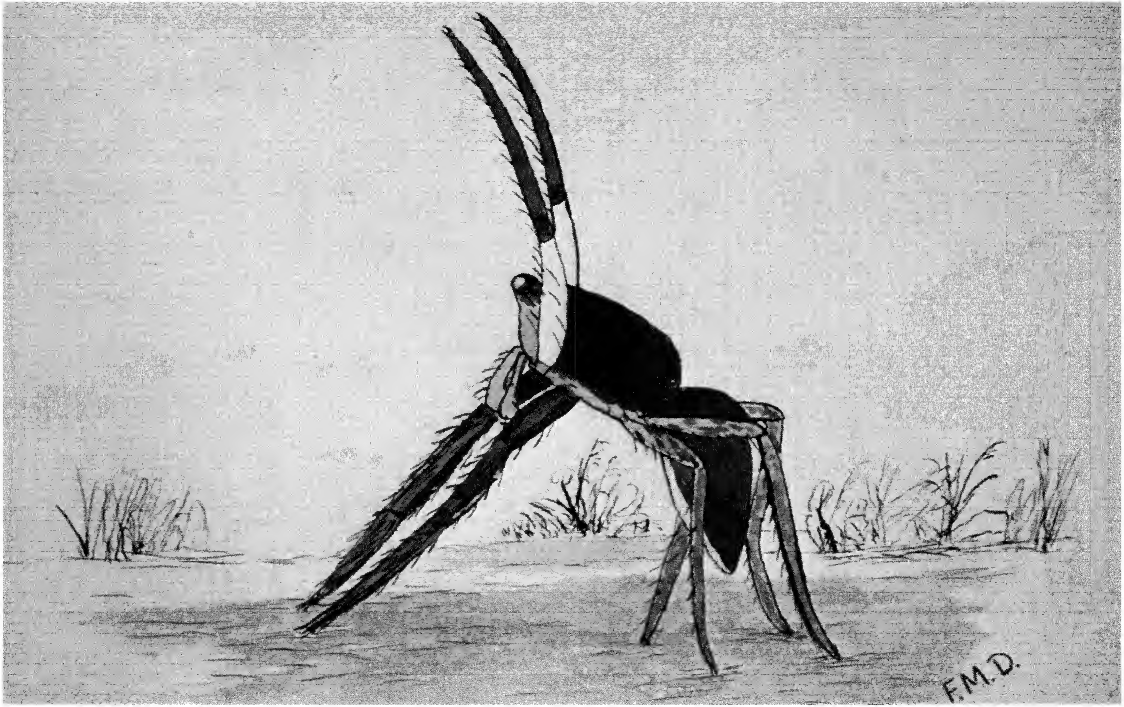

Trembling with excitement the little Attid Spider raises his long front legs as if in salutation ere beginning his courtship dance

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to spin a thread that serves as a life-line to prevent an untimely fall when running up the vertical face of a fence or wall, the female also weaving a cocoon in which to deposit her eggs.

Now just as we find in the different races of the human family strange and varied courtship customs, so in the different species of Spiders we shall find that the methods of courtship vary and are more or less modified according to the habits, size and environment of the interested parties, for Spiders vary enormously in size, from the great so-called Bird-eating Spiders of the Tropics, with bodies nearly four inches long and a stretch of some twelve inches in diameter from leg-tip to leg-tip, to pygmies barely a quarter of an inch in length.

Although not universally the case, still a very large proportion of the different species of Spiders dwelling in all parts of the world are found to have their males smaller and generally more active than are the females. And there is a very good reason for this, for to no other division of the animal kingdom are Kipling's well-known lines—"For the female of the species is more deadly than the male"—more applicable. Countless generations of fierce, fickle, bloodthirsty females have played their part in the evolution of the male Spider as we find him to-day, and produced the queer little creature that he is—courageous, yet timid, patient but restless; and incredibly swift of foot, in many ways a valiant little fellow, a cheery optimist. How different the object of his desire! Often twice or three times his size, though not so agile in

proportion, of surly, uncertain temper; always an hungered, always ready to take offence should he make one false step in the intricate process of their courtship; and instantly to visit her wrath upon the luckless swain by seizing and devouring him, perchance swathing his body in silk and hanging it up in a corner of her web, a grim but disregarded warning to future courtiers. Even after he has been apparently accepted and the act of mating successfully accomplished, unless he leap for his life, she may turn and rend him. So from first to last, courtship in Spiderland is an exciting business, frequently with an abrupt and tragic termination for the male; though there are exceptions, and in some species we find the courtship ending happily, and the pair living together on the best of terms. And this element of uncertainty, and the necessity for alertness and swift movement has served as a very important factor in the moulding of shape, size and habit in the male Spider.

Although none of our British Spiders attain to the formidable size and appearance of many species inhabiting the Tropics, there are a large number frequenting our fields, hedgerows, woods and gardens, that are extraordinarily interesting in their habits, in the wonderful, often extremely beautiful, snares or webs that they weave, and in their curious mating habits. It is with some of the more readily observed and remarkable of these methods of courtship that we are about to become acquainted.

The *Lycosidæ* or Wolf-Spiders are vagabond hunting spiders, that spin no web or snare, but

chase their prey on the ground. About twenty species are found in Britain, some of them being handsomely marked, though of sombre colour and well covered with hair. There is a small Wolf-Spider, known to science as *Lycosa lugubris*, which may be frequently met with in woods in various parts of the country, running over the carpet of ruddy fallen leaves in the autumn. It is brownish black in colour, with a distinctive marking on the upper surface of the body; the male is smaller, has slightly longer and more slender legs, and is much quicker in his movements than the female.

When aroused by a desire for courtship this little male woodland Wolf-Spider runs about over the ground with curious rapid movements of his front legs, scouring in all directions until he meets a female. He then pauses and strikes an attitude in front of the lady, posing with his body raised high and his long, slender first pair of legs stretched out on either side and slightly uplifted. Poised in this position he then proceeds alternately to raise the curiously jointed organs, called the palps, that arise from the sides of the front part of his head, moving them upwards in a series of jerks until first one and then the other attains an almost vertical position above his head, and gently waving his front legs the while. These movements are repeated again and again for several minutes, and then cease as abruptly as they start. He then suddenly begins running sideways round and round the female, who has been watching what we may call the semaphore signalling performance with marked

interest, and as he gyrates he gradually draws nearer and nearer, and, in passing, gently taps and tickles her with his front pair of legs. She may, however, resent this familiarity, and instead of saying in spider language, "Oh! stop your tickling, Jock," will suddenly spring at him with open jaws and chase him away. But, nothing daunted, the enthusiastic little male will return again and again to go through his strange performance, or, should he in his precipitate flight from her sudden onslaught, lose sight of the enraged lady—and I must tell you that although they have a number of eyes arranged on the front of their head, Spiders are not gifted with long sight as we call it—he will wander off to try his luck with another and perhaps less coy divinity.

For our next example of Spider Courtship I have taken a species in which the little male relies upon bribery, rather than posturing or dancing, to win the object of his desire. This is a long-legged hunting Spider (*Pisaura mirabilis*) which is abundant in most parts of England in woods and on commons. It is about an inch or three-quarters of an inch in length, and its elongated body is marked on either side with a sinuous longitudinal line, which gives it a very striking appearance. Both the male and female have long, slender legs, and are very active creatures that do not build a snare, but hunt down their prey. The male is about half the size of the female, and courtship is fraught with very considerable danger for him, unless he has been careful to provide a suitable offering wherewith to satisfy the greed of the fierce and avaricious lady. Indeed,

should he have the temerity to approach a female without a gift, he stands a very good chance of being pounced upon and devoured by her. Therefore, when on courtship bent, he first goes a-hunting, and, having captured a nice, fat, juicy fly, he proceeds to wrap it carefully up into a tiny little silken parcel with silk from his spinnerets. He then wanders off, carrying his parcel—Spiderland's equivalent for a box of chocolates, I suppose—until he arrives in the vicinity of the female, when he proceeds to walk about with a curious, jerky motion to attract her attention. Almost directly the female catches sight of him she darts forward, open-jawed, as if to make short work of his wooing, but he stands his ground and holds out his silken-swathed parcel towards her. Before rudely snatching it out of his grasp, she sinks her jaws into the parcel to test its contents, and then, if the flavour pleases her, calmly takes it and proceeds to devour the fly. It is while her jaws are thus busily engaged, and all is safe, that the little male swiftly slips under her body and mating takes place. It is on record that on one occasion the male was seen to wrap up the dried remains of a fly that he had previously lunched off, and, later, calmly proceeded to offer it to a female he was courting, thus deliberately trying to do the poor lady Spider out of her wedding breakfast! But the cheat was discovered and Nemesis quickly followed, the outraged female pouncing upon and devouring her would-be suitor.

The courtship habits of the Leaping Spiders (*Attidæ*) are among the most remarkable to be

found in Spiderland. This family includes the most handsome and highly ornamented examples of Spider life, reaching its maximum resplendence of colour in the Tropics; so that Wallace, in the account of his observations of these wonders of the Malay Archipelago, speaks of them as "perfect gems of beauty." The males are nearly always more gorgeous in colour and decoration than the females, and, what is most remarkable, go through the most extraordinary dances and gymnastics, just as the magnificent male Birds-of-Paradise do, that their decorations may be shown off to full advantage before the more soberly-clad female, who appears to be influenced by the display of these decorations in the selection of her mate. Natural science owes a great debt of gratitude to Prof. G. W. Peckham and his wife for their untiring devotion to the study of the courtship display of many American species of these remarkable Spiders. In their own words, "the courtship of Spiders is a very tedious affair, going on hour after hour, so that we often worked four or five hours a day for a week in getting a fair idea of the habits of a single species."

The following is a condensed account of Prof. and Mrs. Peckham's observations of the courtship of one of these Attid Spiders (*Saitis pulex*): "He saw her as she stood perfectly still, twelve inches away; the glance seemed to excite him and he at once moved towards her; when some four inches from her he stood still and then began the most remarkable performances that an amorous male could offer to an admiring female. She eyed him

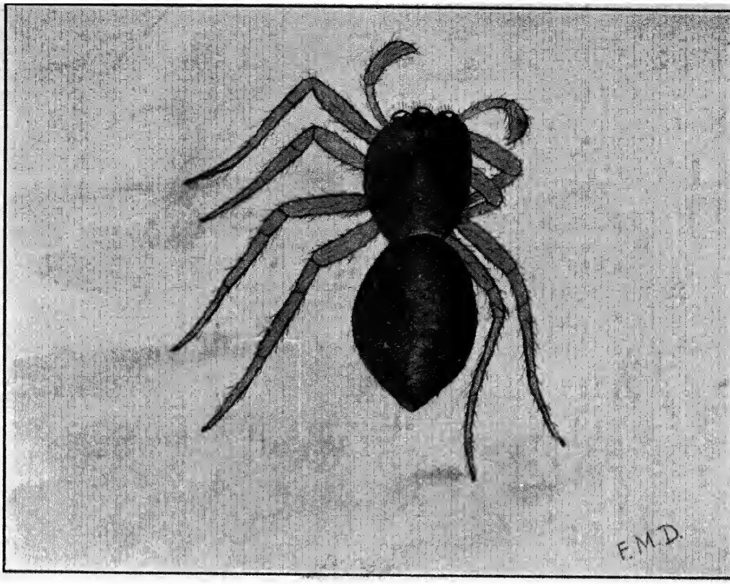
eagerly, changing her position from time to time, so that he might always be in view. He, raising his whole body on one side by straightening out the legs, and lowering it on the other by folding the first two pairs of legs up and under, leaned so far over as to be in danger of losing his balance, which he only maintained by sidling rapidly towards the lowered side. He moved in a semi-circle for about two inches, and then instantly reversed the position of the legs and circled in the opposite direction, gradually approaching nearer and nearer to the female. Now she dashes towards him, while he, raising his front pair of legs, extends them upward and forward as if to hold her off, but withal slowly retreats. Again and again he circles from side to side, she gazing toward him in a softer mood, evidently admiring the grace of his antics. This is repeated until we have counted one hundred and eleven circles made by the ardent little male. Now he approaches nearer and nearer, and, when almost within reach, whirls madly around and around her, she joining and whirling with him in a giddy maze. Again he falls back and resumes his semi-circular motions, with his body tilted over; she, all excitement, lowers her head and raises her body so that it is almost vertical; both draw nearer; she moves slowly under him, he crawling over her head, and then mating is accomplished."

In another American species (*Zygoballus bettini*), the male, during courtship, was observed to lie flat near the female, and to wriggle his abdomen and frequently turn from side to side, while he raised

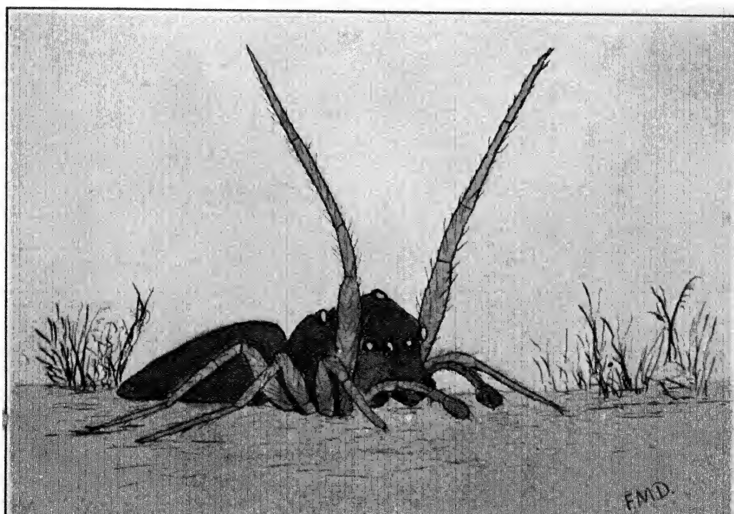
his long, slender first pair of legs almost vertically above his head, and twisted and turned them about. The males of this species also engage in strenuous but apparently bloodless combats, that may last for upwards of twenty minutes at a time, and which may probably be a form of display. They approach each other with open jaws and front legs raised high in the air, and their abdomen bent at right angles to the thorax. Much arm waving takes place, and they will clinch for five or six minutes at a time.

The most familiar of our British Attid spiders is the little, rather strangely marked, black and white striped Spider (*Salticus scenicus*), to be seen hunting on walls and fences during the summer, popularly known as the Zebra Spider. During courtship the little male zigzags backwards and forwards in front of the female in the most comical manner, raising his front legs and stretching them out stiffly on either side. Should the lady retreat, he walks about with queer jerky steps, occasionally twitching his abdomen from side to side, until, drawing near, he resumes his courting antics.

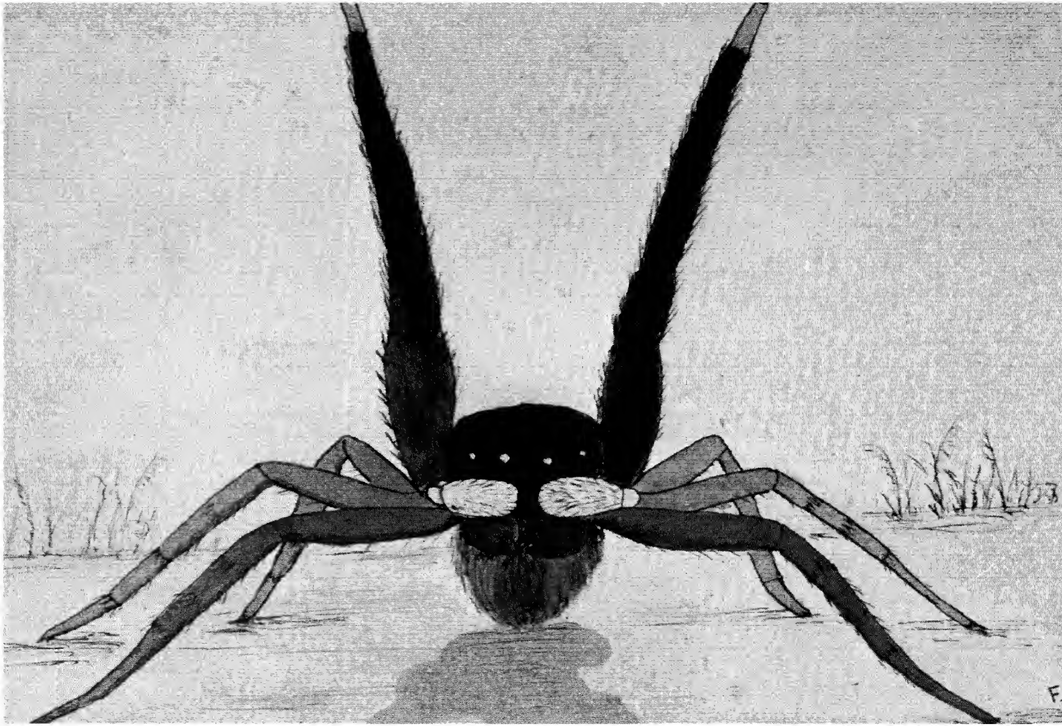
Not quite so common, but the largest of our English species, is the Large Zebra (*Marpessa mucosa*), which is brownish yellow in colour, and also hunts its prey on walls and fences. In this species, when the male comes into the vicinity of a female, he draws himself up rather high on his three hind pairs of legs, raises his abdomen behind, and his front legs at a still higher angle, and then proceeds to dance in a curious zigzag manner, rapidly from



THE START OF THE LOVE DANCE OF THE SAITES



During the courtship Zygoballus crouches close to the ground and raises on high his long slender pair of front legs



Something suggestive of mesmeric passes takes place during the courtship antics of Euophrys

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side to side, as he gradually approaches. All the time the female has been watching him attentively, and when he draws near, either retreats coyly, or rushes fiercely at him and puts him to flight. But he is really at heart a very valiant suitor, and will return again and again, and continue his antics for long periods ere becoming discouraged.

The male of another British species (*Euophrys frontalis*) goes through a very peculiar performance in his courtship display, that almost suggests a series of mesmeric movements. He has very long front legs which are jet black, except for the terminal joint, which is pale yellow. His face is black, and forms a striking background to his large, lustrous eyes, fringed with rust-red hairs, and his yellow palps. When courting, this spider raises his handsome front legs with a curious jerky motion, until they are held almost vertically above his head; they are then slowly lowered until they almost touch the ground, when they are again swept upwards. This movement is repeated again and again, and at the same time the yellow palpi are bent inwards in front of his black face, tip to tip, and vibrated up and down. In this way, alternately raising and lowering his front legs, he slowly approaches the female, who appears greatly interested in the performance, and, if in kindly mood, will reciprocate by movements of her palps and a slight raising of her front legs, and permit him to approach. But should she resent his advances, she will quickly and repeatedly jerk her front legs upwards; a movement that seems clearly to convey a warning

of danger to the male, who will immediately stop his performance and watch her attentively, only, however, to restart his antics directly she stops her aggressive gestures.

In the large Garden Spider (*Epeira diademata*) and the other Geometrical and Web-building species, there is no courtship display, the whole business being confined to telegraphic signals along the silken thread. In the mating season, the ridiculously small male haunts the borders of the female's snare. His action is hesitating and irresolute, as it well may be, for a false step will lead to destruction. Therefore, for hours he will linger on the confines of the web, feeling it cautiously with his long slender legs, apparently trying to find out the kind of reception he is likely to receive should he venture towards the centre of the web. Even when his wooing is accepted, he has to beat a precipitate retreat directly the act of mating has been accomplished, or he may fall a victim to his partner's hunger. Among the Sheet and Tube Weavers, however, the relations between the sexes appear to be more pacific, and there may be even some approach to domesticity, the males and females, during the mating season, living apparently on good terms with each other in their sheet snares.

THE ROMANCE OF SOME SPRING FLOWERS

" And the spring arose on the garden fair,
Like the Spirit of Love felt everywhere;
And each flower and herb on earth's dark breast
Rose from the dreams of its wintry rest."
—SHELLEY.

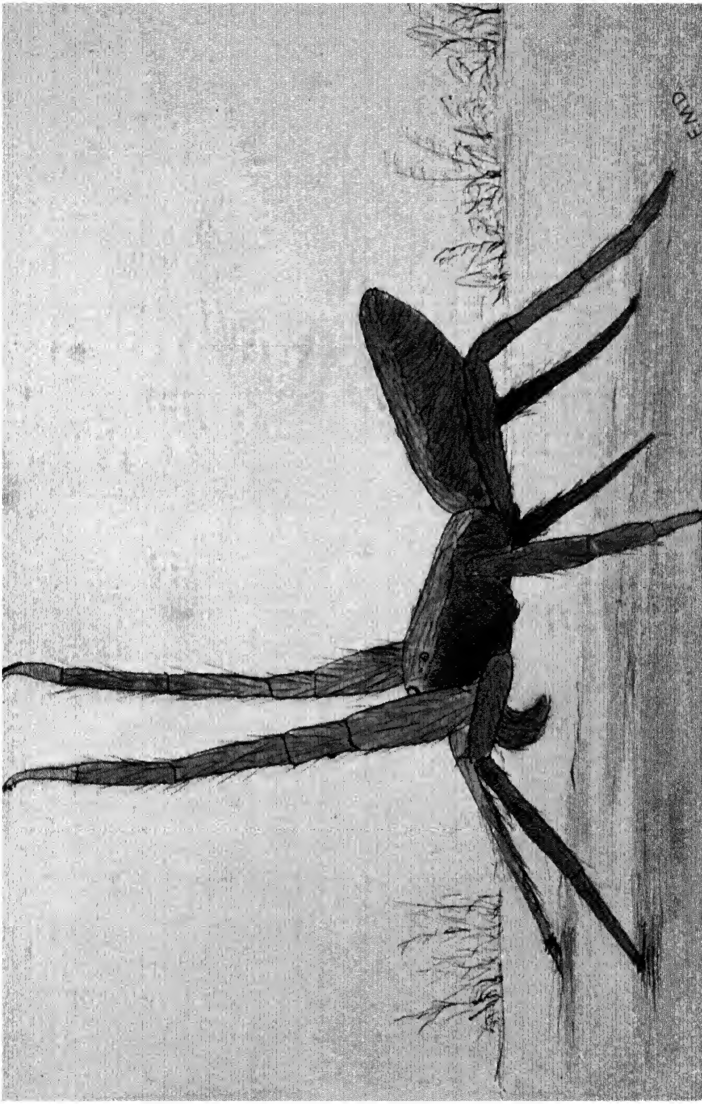
BY the time that these lines are set up in type the spring will be well advanced, and our hedgerows, fields and woodlands spangled with blossoms of varied hue—white, yellow and blue predominating. It is a glorious season of the year, and brings to most of us, even though we may have to dwell in the heart of a busy city, a sensation of hidden joy and expectation. As we look at the baskets of the flower sellers, piled high with golden masses of Daffodils and great bunches of sweet-scented Violets, there comes a feeling of joy, of intense relief, as if the burden of some dark shadow has been lifted, and our hearts are filled with gladness, thankfulness for that unspoken message of hope and the promise of brighter days in store, which these fragrant spring flowers bring to us amidst the toil and din of city life.

This is the season of the year when every hedgerow and copse offers us unending joy and interest, for so many of our wayside spring flowers have a

romantic story to unfold if we will but pause awhile to examine and consider them. Plants, like human beings, have to fight the battle of life, and that plant which can best adapt itself to its surroundings, and can make the most of every opportunity for advancement, is going to be a winner in life's race, just as surely as an alert and well-trained man or woman. Space in which to grow and expand, in which to gain the maximum supply of air and sunshine that their flowers may unfurl and receive the welcome visits of winged insects, more particularly of the bees, so that their seeds may be rendered fertile and their species perpetuated—those are the chief factors in life for our spring flowers.

Here in the hedgerow the beautiful deep-green, arrow-shaped leaves of the Cuckoo-pint, or Lords-and-Ladies, have been making a brave show since the last days of February, and now their gnome-cap shaped spathes are beginning to appear. The common wayside Cuckoo-pint is our English Arum, and just because it is such a familiar object in our country lanes we pass it by without a second thought, yet it is really a very handsome and interesting plant.

The familiar pale green gnome-cap is not really any part of the flower at all, but just a protecting outer leaf, or spathe, as the botanist calls it. As this spathe expands, a deep purplish-red coloured, club-shaped body can be seen within its folds. This is the stem or axis which bears the Cuckoo-pint's curious flowers, hidden from view within the depths of the spathe. This coloured club also serves as a kind of inn sign to attract certain small midge-like



Standing high on his three hind pairs of legs the large Zebra Spider raises his front legs and abdomen and then proceeds to dance

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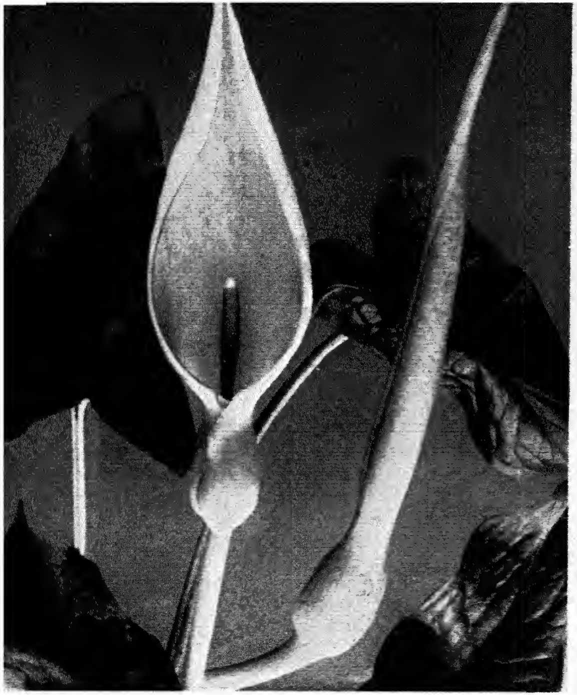
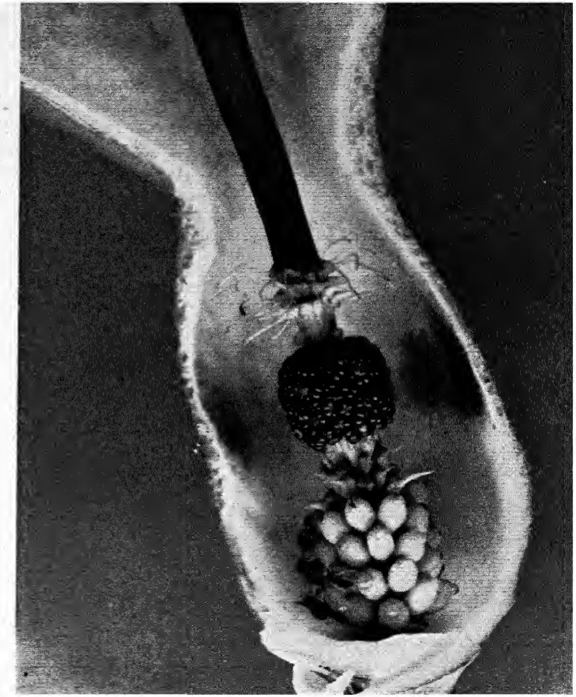


The gnome caps of the Cuckoo-pint have a great attraction for certain midge-like flies



Spathe of Cuckoo-pint cut open showing the curved hairs that act as a trap, the anthers or male flowers and the egg shaped female flowers below on which the midges are

flies, who are the carriers of the golden pollen from one Cuckoo-pint to another, and without whose help the plant would have but a poor chance of fertilising or "setting" its seed. In addition to the club-shaped coloured sign-post, the spathe, when ready to receive the visits of these tiny midges, gives forth a faint, slightly tainted odour that strongly appeals to the wee flies, causing them to alight upon it and eagerly crawl away down inside out of sight. As may be seen in the accompanying photograph the spathe has a kind of waist, which then broadens out again below, so as to form a little chamber at its base; and it is this chamber that the midges have entered.

Now let us gently cut a spathe open to have a peep at the interior. We are then able to see that the handsome club-shaped sign-post bears a circlet of stoutish, downward-pointing hairs, exactly where the waist of the spathe comes, and although they extend outwards, so as to touch on all sides the narrow encircling walls, they will, on account of their downward curve, permit the small midges to push their way from above down into the chamber. Immediately below the circlet of hairs, and on that part of the sign-post's stem which passes through the chamber, can be seen a collection of numerous dark coloured, tiny knobs, which are really the male, or staminate, flowers of the Cuckoo-pint; while below these are the equally primitive, petal-less, egg-shaped female flowers.

Should a mature spathe have been cut open, as shown in the photograph, several tiny midges,

more or less covered with pollen, may be seen crawling about in the chamber below the waist-like constriction. They are temporary prisoners, guests who have arrived from a previously visited spathe, from which they have brought the pollen with which their bodies are dusted. The flies find it an easy matter to push their way past the downward pointing hairs of the waist into the chamber below, but to make their escape again, is, for the time being, practically impossible, for the hairs have considerable resisting powers when pressed from below, and, with the waist, form a kind of lobster-pot trap to hold them captive. The female flowers are the first to mature, and the little prisoners, in crawling about the chamber in search of food, or a way of escape, rub the pollen they have brought from another Cuckoo-pint off their bodies and legs on to the receptive stigmas of these strange egg-shaped flowers. The female flowers having thus been pollinated, or fertilised, through the agency of the tiny flies, with pollen from another Cuckoo-pint, the male flowers above them now ripen and shower down a quantity of pollen upon the imprisoned insects, who feed upon it and at the same time become dusted all over with it. So soon as the male flowers or stamins have showered down their pollen the downward-pointing hairs wither away, the trap no longer acts, and the midges soon make their escape and fly away to another Cuckoo-pint, where they will once more be held willing prisoners until they have performed their duty. It is by this simple yet perfectly effectual device that the

Cuckoo-pint secures the benefits of cross-pollination through the visits of the small midge flies.

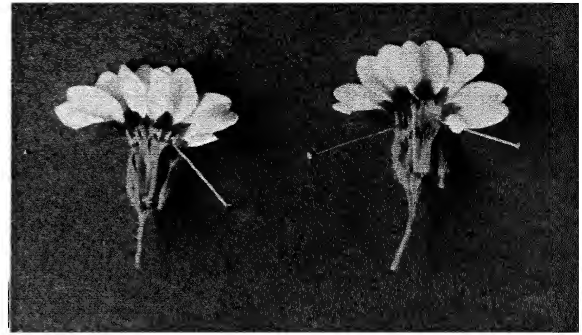
The Primroses, that make every copse and sheltered bank fragrant during April, offer us another interesting example of special adaptation of structure to obtain cross-pollination through the visits of insects.

Probably some of my readers who had the good fortune to spend their childhood in the country, may recall happy, sunny spring days when they went into the woods to gather Primroses, and perhaps played the old game of seeing who could gather the most "pin-eyed," and who the most "thrum-eyed" blossoms. If so, they will very likely also remember that only one kind of flower was to be found on each plant, though where great clumps were growing so close together as to appear to be one plant, "pins" and "thrums" seemed mixed together. For those less fortunate, let me explain that the "pin-eyed" flowers are those in which a little round head, really the top of the stigma, almost fills the entrance to the tube of the flower; while in a "thrum-eyed" primrose certain little tapering processes—the "thrums," really the anthers or pollen-producing organs, occupy the position of the "pin." Supposing we take one flower of each type and carefully slit the delicate tube open. We shall then be able to see that in the "pin-eyed" form the little "pin" or stigma has a long slender stem, and about half-way down the flower tube is a circle of "thrums" or anthers; while in the "thrum-eyed" flower, the "pin" or stigma has a short stalk, so that its head reaches only about half-way up the tube,

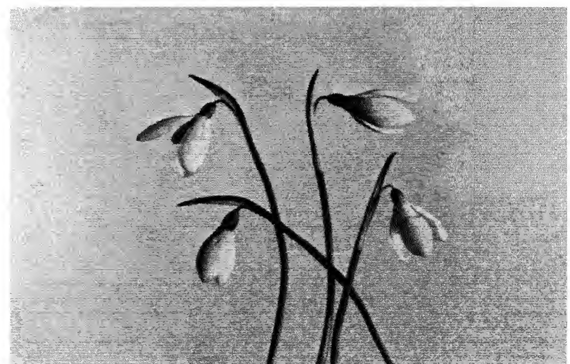
and the "thrums," or anthers, are well above it, filling the entrance. Now when a bee, or other winged insect possessed of a long tongue or proboscis, alights upon a "pin-eyed" flower in search of nectar, and proceeds to thrust its tongue into the tube, the pollen from the anther will become attached at a point about half-way down the insect's tongue; and this will be repeated again and again, so long as it continues to visit "pin-eyed" flowers. But when this insect visits a "thrum-eyed" blossom, then, as its pollen coated tongue or proboscis passes down the tube, it will come in contact with the sticky surface of the short stigma, to which some of the pollen brought from the "pin-eyed" form will be attached. Again, while visiting the "thrum-eyed" flowers, it is the front of the head of the insect that will be dusted over with pollen, which in turn will come into contact with the stigma of the next "pin-eyed" Primrose the insect alights upon. In this manner, as the insects wander from one Primrose to another, they must needs pollinate the "pin-eyed" with pollen from the "thrum-eyed," and vice versa.

The little Snowdrop, which is such an early harbinger of spring, has very often to face most inclement climatic conditions, and but for the perfect manner in which it has adapted itself to the tempestuous season of its flowering, it must long ago have ceased to exist. As the flower-stem first emerges from the ground it grows straight upwards and erect, so that the unopened flower-bud points skyward; but as the bud swells and matures, the stalk begins grace-

The dark green splash of colour on the snowdrop's petals is a guide to insects visiting the flower in search of nectar



Left: A Thrum Eyed Flower
Right: A Pin Eyed Flower




The Leafy Expansion or lure of *Sarracenia* is vividly coloured and bedewed with drops of nectar to attract insect victims


The small lid of the Pitcher is brightly tinted, and serves as a lure. The Pitcher is always about three parts filled with fluid containing many drowned insects

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fully to curve and bend over, so that when the little flower opens it hangs down from the slender stem like a pearly white bell; thus the precious pollen is perfectly hidden and protected from rain by the outer, pure white perianth leaves, which, during cold, wet weather, will remain closed. On fine sunny days, however, the little Snowdrop flower opens about ten o'clock in the morning, and closes again about four o'clock in the afternoon, or earlier should the clouds roll up, obscuring the sun's rays, and the wind blow keenly. Like many other plants that only produce a single flower in the season, the Snowdrop persists fresh, and expands its flower daily for a considerable time, so that should unfavourable weather prevail when the flower first opens, it may, ere its petals fade, have a chance of receiving the visits of insects. Indeed, when a sudden burst of early spring sunshine awakens the bees and sends them forth for a short cleansing flight, they will eagerly seek the Snowdrops, and set all the pearly white bells a-nodding, as they seek for the nectar within each flower. The sweet nectar which the bees seek is formed in the parallel longitudinal grooves on the inner side of the three outspread perianth leaves of the flower, while the single, rigid points depending from the free extremities of the anthers are so placed that the visiting insect cannot help coming into contact with them and receiving a load of pollen, which will in due course be rubbed off on to the viscid stigma of the next Snowdrop that the bee visits. Should bad weather prevail, however, the Snowdrop is unable to secure the benefit

of cross-pollination through the visits of the bees; then towards the close of the flowering period the anthers will relax, or become dislocated in such a manner that the pollen will fall upon the still viscid and receptive surface of the stigma, so that, through self-pollination, the setting or fertilisation of the seed is assured.

On the railway embankments and pieces of rough waste ground the golden flowers of the Coltsfoot make a brave show at this early season of the year, but no trace of foliage shows above ground. Not until the flowers have all been pollinated, the seed set, and the golden yellow heads changed to white, feathery down, which, on the maturing of the seeds, helps to carry them away on the wings of the wind, will the foliage leaves begin to appear; so that during the whole of the flowering period the ground is bare, and there is nothing to attract the attention of the first flower-haunting insects of the spring from the golden glory of the Coltsfoot flowers.

Such is a brief outline of the romance of one or two familiar spring flowers of our fields and hedgerows. It would be impossible within the space available here to describe all the varied and fascinating methods by which our numerous spring flowers obtain the benefit of cross-pollination through the visits of insects, but perhaps the examples chosen may suffice to give an added interest to country rambles at this season of the year.

NATURE'S FLY-TRAPS

SHOULD a holiday tramp take us over a stretch of open moor or common-land, where patches of marshy bog support a luxuriant growth of sphagnum or bog moss, there we are likely to find one of Nature's most interesting Fly-traps, the little Sundew. It is by no means an uncommon plant in such situations, although unfamiliar to most people because of its modest size and the somewhat uninviting character of the water-logged bogland where it flourishes at its best, the soft greys and greens of the sphagnum moss forming a beautiful background to its reddish-coloured, sparkling leaves.

The Sundew grows close to the ground, among the surrounding moss, its rosette of three, five, six or more leaves spreading out at right angles from the very short stem. The slender little leaf-stalks each terminate in a round salt-spoon-shaped leaf; or, if we are lucky enough to find the rarer oval-leaf Sundew (*Drosera anglifolia*), the leaves will be shaped like miniature mustard spoons. Both the slender stalks and leaves are covered with numerous club-shaped hairs that look as if they were tipped with dew-drops, giving to the whole plant, when seen in bright sunshine, that sparkling appearance from which it has gained its popular name of the Sundew.

These hairs are really very wonderful in their structure, more like sensitive fingers or tentacles, for they are capable of independent movement, and although indifferent to pattering rain-drops or particles of wind-blown dust, yet responding to the lightest touch of the tiniest midge or other winged insect that may have the misfortune to blunder against one. There are from one hundred to two hundred and sixty or more of these delicate hairs on every leaf, and each terminates in a small, knob-shaped swelling or gland, surrounded by a large drop of sticky secretion which glistens brightly in the sunshine. In the centre of the leaf these glandular hairs are short and erect, with greenish stalks; while nearer the margin they increase in length considerably, have a pale purple hue, and curve slightly inwards like long slender fingers.

Having found a colony of Sundews growing on the moorland, let us pause awhile and watch those sparkling leaves at work. We shall not have to wait long, for many small gnats and other flies are on the wing, enjoying the warm summer sunshine. One of the insects, in the course of its flight, incautiously approaches too near, touches a hair, and is at once entangled by the sticky secretion of the gland. The more the insect struggles, the more hopelessly does it become involved, its frantic movements simply serving to bring it into contact with other hairs, which have already begun to curve towards it and to pour forth an abundant secretion. This incurving of the long marginal hairs helps to shift the unfortunate fly towards the centre of the

leaf, which gradually becomes slightly concave, like the hollow of your hand when the fingers are bent inwards. Gradually these hairs close over their victim, making escape impossible. The glands on the ends of the hairs continue to pour forth their sticky, viscid secretion, which soon permeates the captured insect, and, acting as a digestive and solvent, reduces all the soft, soluble parts, which are then absorbed.

The actual time taken over the meal will, of course, depend upon the condition of the leaf and the size of the insect, it varies accordingly from a few hours to a couple of days or more; while, should the leaf have captured too rich a prize, it may actually die of indigestion, and never again expand to its normal state. Usually, however, the banquet finished, the leaf and its hairs once more expand, the glands for a short time cease to secrete, and the dry skin of the fly is soon blown away by the wind. After a period of rest the leaf will then be ready for another meal.

The glistening secretion of the glands at the ends of the hairs of the Sundew very closely resembles the gastric juices of animals, and contains a digestive ferment and several acids. This has been proved by chemical analysis; as well as by direct experiment, by placing tiny morsels of boiled white of egg and roast meat upon the leaves of the Sundew, where they have been dissolved. It has also been proved that while the leaves can first dissolve and then digest morsels of beef, cheese, boiled white of egg, and the like, they cannot digest the hard parts of

insects (*chitin*), fragments of horn, cellulose, and other similar substances incapable of digestion by animals. Moreover, it has been shown that the chemical constituents of the secretion vary according to the nature of the object placed on the leaf; no digestive ferment being secreted until the glands have absorbed a trace of animal matter. This selective power is of great importance to the plant, as insoluble inorganic objects, such as grains of sand, must often be blown on to its leaves in dry dusty weather.

Altogether the Sundew is a very remarkable and interesting plant, and one well worth keeping under observation. This is not a very difficult matter, provided a little care is taken in supplying it with plenty of moisture. The best plan is carefully to lift a small mass of Sundew, along with the surrounding moss and some of the poor peaty soil, and to place the lot in a good sized shallow earthenware saucer, such as is used by gardeners for standing flower-pots on in greenhouses. If kept thoroughly moist the plants will soon recover from the shock of being transplanted, and you will be able to watch the fly-trap leaves at work.

Another of Nature's Fly-traps worth seeking is the little Butterwort (*Pinguicula vulgaris*), which, though not so common as the Sundew, lives in similar marshy situations, particularly on high wet moorlands and the banks of shallow becks flowing down from the hills. Like the Sundew, it is of modest size, its rosette of plump, glistening green, slightly incurved leaves nestling close to the ground,

and sending up from their midst a slender upright stalk crowned with a lovely violet-tinted flower. The upper surfaces of the broadly oblong leaves are covered with minute stalked and unstalked glands, which exude a copious viscid secretion, and have a faintly fungus-like odour which appears to have a special and fatal attraction for many small flies and midges. Indifferent to rain drops, or sand grains blown by the wind, the plump little leaves, to which the plant owes its quaint scientific name (*Pinguicula*, literally, little fat one), respond directly any small insect incautiously alights upon one. Under such stimulation the glands increase their secretion, while the edges of the leaf very slowly curl inwards, so as to bring the struggling insect into the trough of the leaf and in contact with as many glands as possible. The secretion poured forth from the glands, like that of the Sundew, has a dissolving and digestive action, so that in a little time all that remains of the captured insect are a few insoluble chitinous fragments. The Butterwort has long been known as a useful plant by the country folk of Northern Europe and Scandinavia, for the great Linnæus noted that the Lapps used it for curdling milk, while at one time it was a country custom to apply the leaves as a dressing to the sores of cattle.

One of the most celebrated of Nature's Fly-traps is found growing in marshy places in the east of North America, where it has a very restricted distribution in North and South Carolina. This is the famous Venus's Fly-trap (*Dionæa muscipula*), the first of these

curious plants to attract attention by its insect-capturing habits, which were described by the old English naturalist, Ellis, so far back as 1768; though at that time it was generally thought that the insects were accidentally caught and later permitted to escape.

Like the Sundew and the Butterwort, the Venus's Fly-trap grows in moist places and has a circle of more or less prostrate leaves. But there the resemblance ends, for this plant does not capture its insect prey by means of sticky secretions, but by the rapid closure of its leaves. Around the edges of the slightly oval bilobed leaf are a number of stout long hairs, which, when the two lobes close, interlock together so as to form a perfect miniature rat-trap, from which escape is impossible. The centre of each half-leaf is furnished with numerous rosy tinted glands, and on each side there are three weak hairs, having a basal joint, so that they fold flat without injury when the leaf closes. These hairs are extraordinarily sensitive, in fact they are the springs that cause the trap to close; for an insect, if small enough, can wander over both surfaces of the leaf provided it does not touch one or more of these control hairs. The moment they are touched, the leaf closes upon its prey, and becomes converted into a temporary stomach for the digestion and absorption of the soluble parts of the insect, which are dissolved by the secretion poured forth by the rosy-tinted glands, now stimulated into action by contact with the imprisoned victim. The feast accomplished, the leaf re-opens, and remains for a

THE LEAF OF THE SUNDEW WITH A FRESHLY-CAPTURED INSECT

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Pitcher Plants Growing in their Natural Environment

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time in a torpid condition. It is probable that even under natural conditions each leaf is only capable of digesting two to three substantial meals during its life, for should it close upon a relatively large insect, the leaf will never open again, but pays the penalty of its gluttony.

Two equally remarkable Fly-traps inhabiting North America are the Side-saddle plant (*Sarracenia*), with a range of distribution from Florida to Canada, and the *Darlingtonia californica*, which grows in marshy ground in the region of the Sierra Nevada. The leaves of the Sarracenia are shaped like slender trumpets, having a gaily tinted, more or less circular expansion growing out from one side of the mouth, or "bell" as we should call it when speaking of a real trumpet. In the early summer this vividly-coloured leafy expansion is bedewed on its inner surface with drops of sweet nectar secreted by special honey glands. As these drops increase in size they tend to trickle downwards towards the opening into the funnel, their course being guided by the coating of fine but short, stiff hairs which cover the leafy expansion, or lure, for it is really this portion of the curious leaf that acts as a bait for honey-loving, unwary insects. An insect alighting upon the eminently attractive surface of the lure, sips at the drops of nectar, and naturally begins to move downwards to explore the interior of the funnel in search of more. Just inside the mouth of the funnel the honey-glands and fine hairs end, and give place to a smooth polished area, aptly called the conducting surface; a sort of glassy, tessellated

pavement, down which the exploring insect quickly glides, on to the detentive surface which forms the lining of the whole of the lower part of the funnel. This detentive surface is covered with long, stout hairs, all sloping slightly outwards and pointing downwards, making descent an easy matter, a veritable road to ruin, from which return is impossible. The diameter of the funnel is here too narrow to permit the use of wings, and both legs and wings of the struggling insect become entangled by the innumerable stiffly pointed hairs. In its natural habitat, the Sarracenia secretes a considerable amount of fluid, which collects at the bottom of the funnel and has a peculiarly fatal effect upon the insects that eventually fall into it. Although Sarracenia plants grown under glass in this country do not appear to secrete any appreciable amount of this fluid, they are quite as successful in the capture of prey, the leaves often becoming filled to a depth of five or six inches with the remains of dead insects, of which a large proportion often consists of bluebottle flies and wasps, carrion loving creatures who were probably doubly attracted by the sparkling drops of nectar on the lure, and the fœtid odour of the decaying bodies of relations who had already perished.

In Darlingtonia, the lure is reduced to a brightly coloured streamer, the leafy expansion being modified into a large and roomy hood, whose walls are pitted with innumerable glistening, translucent spaces that serve as so many semi-transparent windows. The opening to the hood is relatively small but easy of

access to any inquiring insect, and is invitingly baited with honey-glands.

Who has not watched and marvelled at the stupidity of a moth, bee or other winged insect which will continue to beat its head against a window-pane or ceiling in an effort to escape into the outside world, though the window be wide open? The reason for this is that apparently most insects are really very short-sighted, having eyes of peculiar structure, large and very convex, so that they fill the sides and top of the head, and therefore, seeing abundant light coming from above, tend to spread their wings in an attempt to fly upwards. The same action takes place with the imprisoned insect within the wide hood of the Darlingtonia, the numerous semi-transparent spaces covering its roof giving the impression, like the ceiling in a room, that that way lies escape. Eventually tired or exhausted, the victim descends into the funnel of the Darlingtonia leaf, whose walls are very similar to the conducting and detentive surfaces of those already described in Sarracenia.

And now we come to those wonderful Fly-traps, the true Pitcher Plants (*Nepenthes*), which abound in the Malay Archipelago, and spread from thence into North Australia, Cochin-China, Bengal, Ceylon, and that island of animal, insect and plant wonders, Madagascar. Though so widely distributed throughout the Oriental tropics, all species of Nepenthes resemble one another in that the Pitcher is always borne at the end of a long tendril-like prolongation of the leaf. Of course, the Pitchers

in the different species vary in size considerably, some attaining to twelve inches or more in depth, while all are very graceful in shape, and richly tinted. The "lid" of the pitcher, like the lure of Sarracenia, bears many nectar secreting glands, and serves the same purpose in attracting honey-seeking insects. They alight and approach the mouth of the pitcher, the surface of which is beautifully fluted and has its edge turned inwards and downwards, adorned with flask-shaped glands which lead the unwary insect on and over the edge of the slippery conducting surface to the fluid with which the pitcher is about three parts filled. This fluid is not a mere collection of rain and dew, but has been secreted by special glands, with which the lower inner surface of the pitcher is lined. Like the sparkling secretion of our native Sundew, the fluid in the tropical pitcher has dissolving and digestive powers, and has the same extraordinary wetting powers, due to the presence of a constituent called azerin. Professor Tait, who discovered this deliquescent substance, describes how he placed living flies in tubes containing respectively, distilled water, fluid drawn from a Nepenthes pitcher, and a solution of prepared azerin. The flies in the tube containing water touched the surface again and again without ever getting completely wetted, and lived for a very long time—probably as long as if they had been placed in a dry tube. On the other hand, those flies placed in the tubes containing the Nepenthes fluid and azerin solution were completely wetted in a very few minutes after they had once touched

the surface, quickly became immersed and drowned. Obviously, this property of rapidly wetting any object with which it may come in contact, is of prime importance to Pitcher and Sundew alike, in preventing the ready escape of their active prey.

For proof that these wonderful Fly-traps do not altogether have matters entirely on their side, we may return for a moment to the consideration of the American Sarracenia. Careful observation in the field has shown that at least two species of insects and a spider contrive to utilise the Sarracenia to their own advantage. The first insect is a species of blue-bottle-fly, which deposits a few eggs just inside the funnel-shaped leaf. From these eggs the larvæ or maggots hatch out, and by means of specialised long claws and cushions on their legs are able to grip the long hairs of the detentive surface and make their way down to the bottom, where they feast at ease upon the dead carrion. When that supply of food has disappeared, they start to devour one another, so that, finally, only one survives, a living mausoleum to his two or three brothers and sisters. But not always does this cannibalistic glutton live to bore his way out and burrow in the ground to complete his life history, for an avenger in the shape of an insect-feeding bird may visit and slit up the sheltering Sarracenia tube, and devour the whole of its insect contents. The second insect is a moth with curious long spurs upon the second joints of its legs, which cross many hairs at once and so enable it to walk over the dangerous detention surface

without becoming entangled. Its larvæ, or caterpillars, spin silken strands over the tips of the detentive hairs, and feed upon the tissues of the Sarracenia, especially upon the nectar glands of the attractive surface, ultimately passing through their pupa stage within the shelter of the funnel. Lastly, we have certain spiders who spin their primitive webs over the entrance to the trumpet and capture the insects attracted by the nectar-secreting lure.

Finally let us try to gain some idea of the real significance and utility of this fly-catching habit. All the plants we have been considering—Sundew, Butterwort, Sarracenia, Nepenthes—grow in wet, boggy soils, which are very deficient in nitrogenous salts, so essential to vigorous growth. Moreover, they are often so loosely rooted, and this particularly applies to our native Sundew, as to be ill adapted to absorb these salts from the soil direct. Therefore, the power of obtaining necessary supplies from other sources is all important, and the reason for the gradual development of the power of insect capture and subsequent digestion and absorption becomes obvious.

It is partly from a closer study of these natural Fly-traps, and from many other plants that move in response to touch, as we see in the tendrils of sweet-peas, hops, and other climbers, that our knowledge of the living plant has been greatly increased of later years, so that we now begin to realise that plants and animals have much in common, and that we can no longer think of plants

in terms of cabbages and potatoes. For once modern research has added romance to the countryside, Dryad and Nymph once more dwell in the Oak and Aspen, and through stem and branch of tree and vine that same universal mysterious life-principle flows as through our own living bodies.

CHRISTMAS AT THE COUNTRYSIDE

> "Winter slumbering in the open air,
> Wears on his smiling face a dream of spring!"

Yes, even at mid-winter, no matter how rough the weather may be, there is a subtle charm and promise of future good in the open country, that cheers and fills one with renewed hope. There is always something going on in the fields and hedgerows or the moorlands and hills to attract and awaken interest; while at sunset, and again at sunrise, on the mud-flats and along wide stretches of marsh and sandy seashore, flocks of feathered visitors, migrants who have paused to rest and feed before continuing their long mysterious journey southwards, may be seen. For the real lover of Nature, the countryside in winter is never dull or dreary.

True, a large proportion of Nature's children, nearly all the plants, a vast number of insects, and even some of her four-footed children have gone to sleep; but slumbering "dream of spring." And what a wonderful thing that long winter sleep really is! A period of profound rest, preparatory to that renewal of vital energy for the work of the coming spring, when Demeter, the great Earth-Mother, will

A Squirrel Building his Nest high up in the Branches of a Pine Tree

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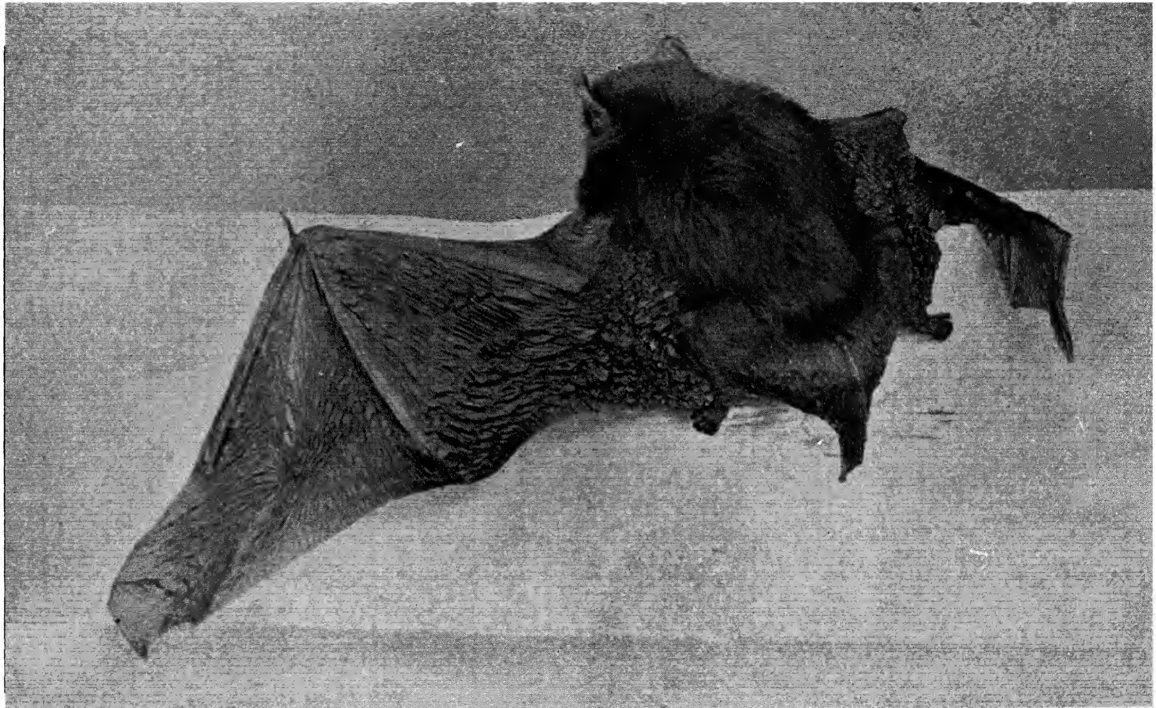

THE BAT

Is one of Nature's much maligned children. Useful and harmless it should be protected and encouraged

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once more quicken the life of dormant seed and bud, and stirs the slow pulses of the furry sleepers. It is a wonderful story that old Greek nature legend of Demeter, and some day, perhaps in the spring, for that would be the most appropriate season of the year, I shall hope to show how intimately it is connected with the passage of the seasons; but now it is mid-winter, the period of rest, therefore let us seek for some of these furry sleepers.

If the weather be really seasonably cold, we may certainly count on finding the Dormouse at home, comfortably tucked up, and sound asleep. Quite early in the autumn the little creature built a snug nest, composed of dried leaves, grasses and moss, in the midst of a dense thicket on the borders of a flourishing hazel copse, and laid up a good store of seeds and nuts to last him through the winter months. The little Dormouse is sleek and fat, for he has not spent the warm summer nights in sleep, but in active climbing and squirming through the hedgerows, feeding to his heart's content upon the ripening fruits and seeds; while in late spring and early summer he had a wife and family to look after. Now, however, should we have a cold and frosty Christmastide, we shall find him comfortably tucked up in his nest, sound asleep, with his body slightly curved round so that the dainty little hands and feet are held more or less closely against the under surface of the body, while the nose is protected from frost-bite by the stout furry tail that curves up over the face and top of the head.

Profound as his torpor may be during a spell of severe cold, the Dormouse does not sleep steadily on throughout the whole winter. Whenever the south and west winds blow, bringing a grateful rise of temperature and a spell of mild weather, the Dormouse awakens and takes toll of his winter store of food, and, having thoroughly satisfied the pangs of hunger, settles down for another comfortable sleep, to await the return of spring.

In the heart of a great wood, high amidst the branches of an old Scots pine tree, the Squirrel has built his winter quarters, a snug and roomy nest, composed of moss, leaves, grasses and fibres, all skilfully woven and interlaced together. Like the Dormouse, he has been busy during the late autumn laying up stores of food, seeds, hazel and cob nuts, beech-mast, for winter provision; deposited for safety in several convenient holes in the trees in the immediate vicinity of his winter quarters. When he is busily engaged in the gathering in of this harvest, he is very wrath at being disturbed, and will chatter and scold at you from a safe vantage point among the branches. The Squirrel is a much more restless creature than the Dormouse, and I am inclined to think that he does not spend such long periods of the winter in sleep, at least not in the south, judging from the freshly fallen fir-cones which one often sees beneath the trees, even when the ground is powdered with freshly fallen snow; bearing unmistakable evidence of having formed part of a Squirrel's recent meal.

And what a woodland elf he is! Leaping from branch to branch with amazing agility, and playing at hide and seek round the tree trunks, peeping down at us with his sharp, beedy eyes, and chattering disapproval at our presence. It is an abominable shame to imprison so lithe and active a creature in a cage, and unless the poor little prisoner has been captured quite young, it soon dies of a broken heart. Of the cruelty of caging an adult Squirrel, let the following incident suffice: Walking down a street in London one spring afternoon a few years ago, my attention was arrested by the sight of a cage containing an adult Squirrel exposed for sale in a shop window. The poor little animal was making frantic dives from side to side, and a wound on its nose was bleeding, caused by its fruitless efforts to force a way out. I purchased the unfortunate animal and took it home with me. In the quiet of my study, the little creature grew calmer, and as the days slipped past, less frightened, so that it ceased to dash about at one's approach, and its poor nose healed up, though the scar remained. It was a tragic sight, however, to see the expression of intense longing on the eager little face, pressed against the bars of the cage, peering out at the garden beyond. I had no intention of attempting to keep the poor little animal as a pet, and had only purchased it that I might at the first suitable opportunity give the Squirrel its freedom. A few weeks later the chance came. I had to pay a lengthy visit to a part of the New Forest, and I took the Squirrel with me. The journey greatly alarmed him, and I

thought it wise to keep him for a day or two in my rooms to recover. Moreover, I wanted time to find a suitable bit of woodland, not already in the possession of a strong and active free Squirrel, for these creatures have their own recognised territories among the tree-tops, and woe betide the stranger who dares to trespass thereon. Having found a likely copse of young beech and hazel, I started out one bright sunny morning, carrying the cage containing the Squirrel. As we left the road and struck into the woods, the little fellow became tremendously excited, plunging in and out of the sleeping-box, and running round his cage.

At last we arrived at our destination, and, placing the cage on the ground not far from a pine tree, I opened the door of the cage wide, and then hastily retired to a point where I could watch my little furry friend without his seeing me. In a very few minutes he came out from his sleeping-box and sat up on the floor of the cage, peering excitedly in all directions. Then he made a dart to the open door, and, resting his paws on the edge, looked out, but as yet did not seem to be able to realise that that way lay freedom. Instead, after gazing intently for a few minutes, he gave vent to a low wailing note and dashed back into his sleeping-box, as if, poor wee tragic creature, the sight of the woodland was more than his tortured heart could bear. A few minutes passed, and once again the little fellow appeared at the mouth of the sleeping-box, paused, and then made for the open door of the cage and looked out. It was all very quiet in the early

morning sunshine, almost as if Nature had hushed her other children lest they should frighten that prison-scared, pathetic little creature, standing at the open door. Further and further, head and shoulders now are stretched beyond the door—is it? can it be true? the eager questioning eyes seemed to ask. And then, at last, yes, freedom, and in an instant he was gone.

Some weeks later, the work which had brought me to the Forest finished, I spent a last hour in that particular glade, and had the pleasure of a glimpse of my little friend high up amidst the branches. I could see the old scar on his nose through my field-glasses, so I knew that it was my Squirrel, free and happy, established in his own territory.

Other of Nature's children who sleep most of the winter away are the Bats. All through the warm summer nights, aye, and far into the autumn, if the weather keeps warm and open, they have whirled and turned and darted in swift pursuit of their insect prey. Then as nights grew chill and frosty, they hung themselves up by their toes in hollows in the old oaks and elms, in the roof-trees of the barns, and the grey old church tower, anywhere out of reach of the full glare of daylight, where they would be snug and undisturbed. Our Common Bat, or *Pipistrelle*, probably spends the least time in winter sleep, or hibernation, of any British species, for it rarely retires to its winter quarters before the end of October, or the middle of November, should the weather continue sufficiently mild, and generally reappears on the wing again in the lengthening

twilight of mid-March evenings. The Long-eared Bat appears to enjoy a slightly longer period of seclusion, while the winter sleep of the Noctule Bat lasts from October to early April. I must confess that I am always at a loss to understand why these gentle, useful, and altogether harmless animals should awaken such aversion and fear among most people, should one fly in at the window. Our British Bats are all purely insectivorous in habit, and really do valuable service in devouring large numbers of winged insect pests; while there are few things more wonderful than the flight of a Bat. Should one enter a room, it will fly about in all directions, darting, diving, twisting, turning with incredible swiftness, yet never touching any object; and, if undisturbed, will soon fly forth again into the warm scented night in pursuit of its natural prey. On the other hand, a wild bird will dash about in great alarm, knocking your pet nicknacks off the mantel-piece, and colliding with the pictures.

The Hedgehog is another sound sleeper. As winter approaches it will seek out some secluded and convenient spot, such as an excavation in a sheltered bank; a hollow under the roots of some ancient beech or oak; or in the midst of the tangled brushwood of a sheltering hedgerow. Wherever the nest may be, it is composed almost entirely of withered leaves and moss, and the animal having entered its winter retreat, appears carefully to close up the entrance before curling up and going to sleep. The Hedgehog does not lay up any store of winter food; it usually retires to its nest in

November, with the coming of cold, hard weather, remaining for lengthy periods in profound slumber, only coming forth should a spell of mild weather supervene.

Cold weather makes keen appetites, and the Stoat becomes increasingly bold and daring in his hunting. The poor Rabbits, I am sure, must wish that he might change his habits and become a winter sleeper, for many a gentle Rab meets a sudden and tragic end, and makes a Christmas banquet for the fierce, agile little Stoat. It is curious, that although so much superior in size and weight, and capable of rapid movement, both the Rabbit and the Hare, when being hunted by a Stoat, appear soon to be overcome by fear; and, giving vent to most piteous cries, crouch down to await the onslaught of their foe, who kills by biting through the arteries of the neck. Yet a female Rabbit will at times display extraordinary courage when her offspring are molested, violently charging, and not infrequently actually putting to flight, a badly disconcerted and surprised Stoat. In its winter pelage, in the north, the Stoat is known under the name of Ermine, when the brown hairs on the head, body, and base of the tail loose their russet brown and become a creamy white. But in the south this complete change of colour rarely occurs, the winters not being sufficiently severe. In Northumberland and Scotland it is very general.

On frosty, moonlight nights the Owls swoop round the ricks and barns like winged ghosts, pouncing on the mice and rats that are abroad

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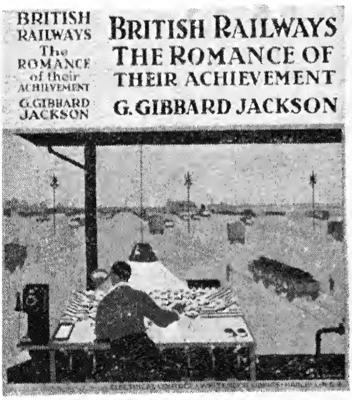

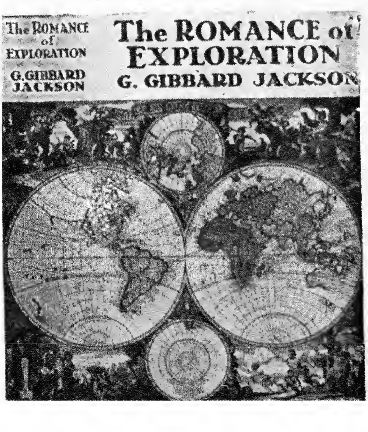

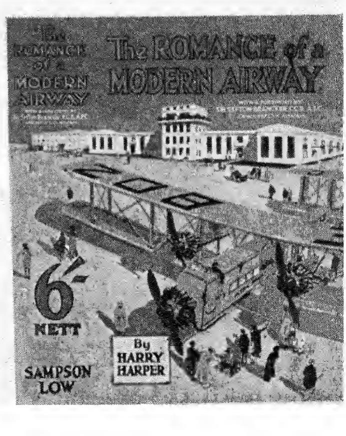

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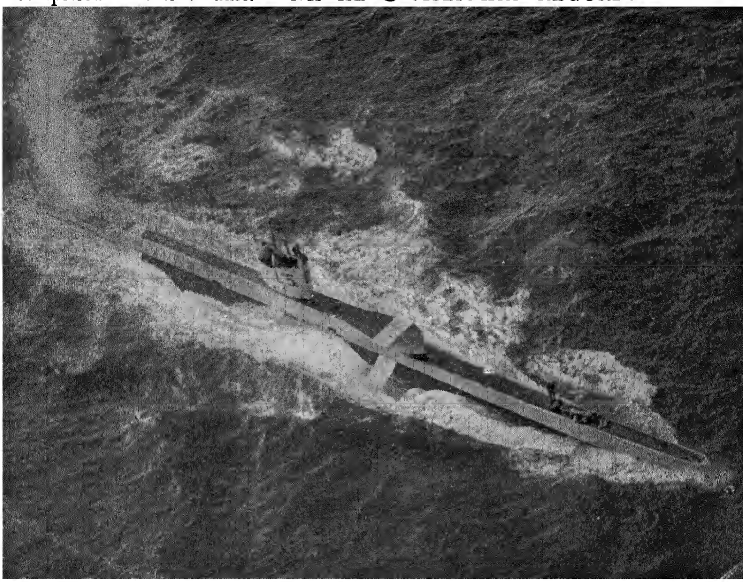

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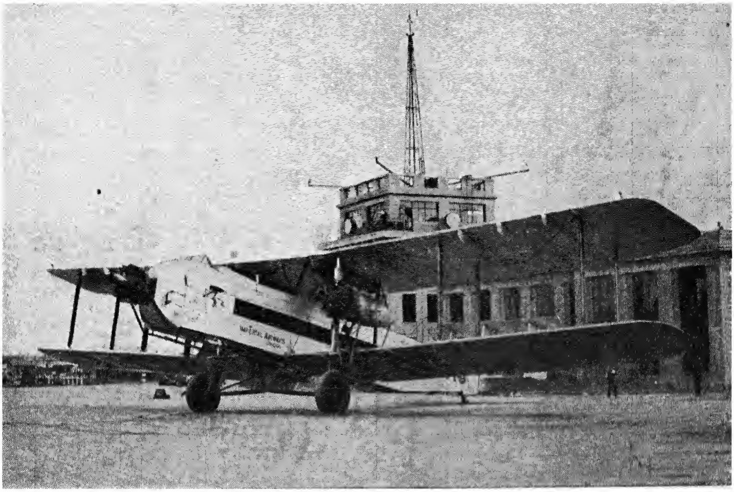

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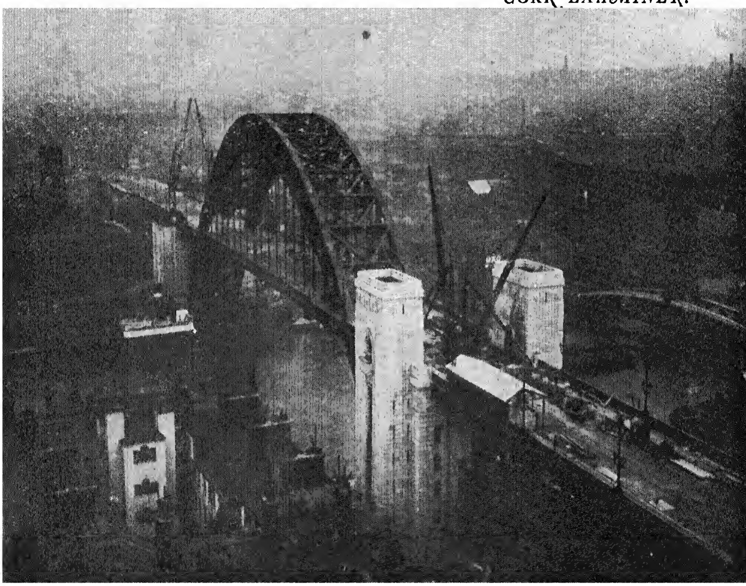

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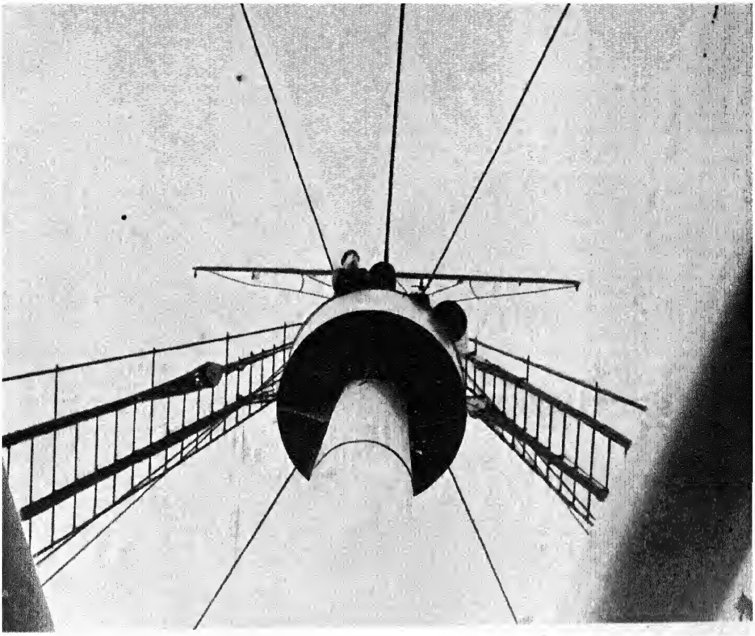

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With a Foreword by

REAR-ADMIRAL E. R. G. R. EVANS, G.C.B., D.S.O.

Rear-Admiral Evans in his foreword says :—"'The Romance of Navigation' is of absorbing interest from cover to cover, besides promising to be a standard work, coming, as it does, from the pen of an artist in literature as well as in sea culture."

"'The Romance of Navigation" is a book to have and to keep"
—*NORTHERN DESPATCH.*

"A most charming and interesting volume."
—*NAVAL & MILITARY RECORD.*

"It constitutes a wonderful record of the sea and seamanship."
—*YORKSHIRE OBSERVER.*

THE BLUE RIBAND

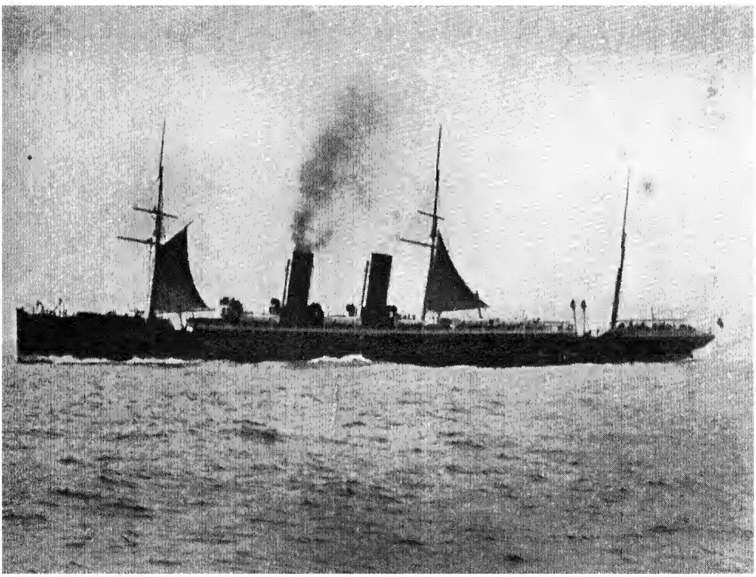
THE ROMANCE OF THE ATLANTIC FERRY

CHARLES E. LEE

Assistant Editor of "The Marine Engineer"

Editor of "The Aviation Year Book"

In this volume, Mr. Charles E. Lee gives a readable narrative covering th events, personalities and vessels which make up a century's history in the join. of the old world and the new with speed, comfort and safety. It is fully illustrated with coloured plates, half tone illustrations and line drawings, which constitute in themselves a fascinating picture gallery to all who are interested in the sea.



An Early Cunarder, Under Sails and Steam.

An illustration from "The Blue Riband."

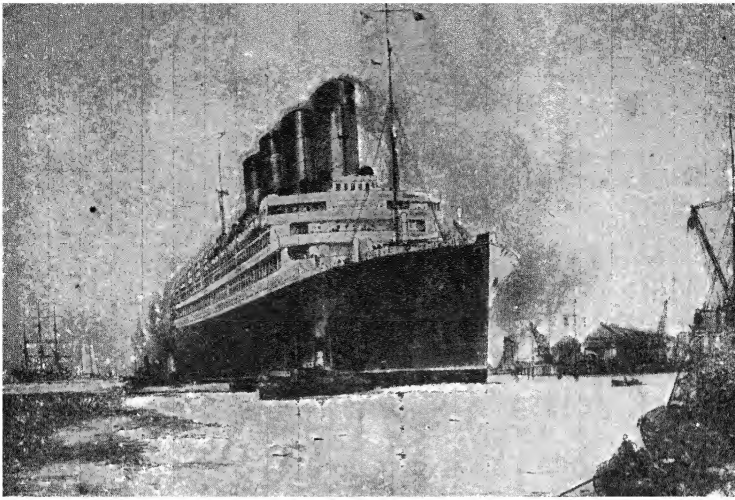
THE OLD FLYING DAYS

MAJOR C. C. TURNER, A.F.R., Ae.S., M.I.Ae.R., F.R.G.S.

Major Turner's object, he says, has been to recall the spirit, the atmosphere, of the first phase of practical flying. He has succeeded."—*DAILY MAIL.*

"Many books about the air seem to have been forced unwillingly into existence by their author's sense of duty or responsibility. Major Turner' book, on the other hand, is a spontaneous story that demanded writing."

—*THE MORNING POST*



R.M.S. AQUITANIA AT SOUTHAMPTON.

A reduced illustration from "The Romance of a Modern Liner."

THE ROMANCE OF A MODERN LINER

CAPTAIN E. G. DIGGLE, R.D., R.N.R.

(Commander of R.M.S. Aquitania).

With a Foreword by

ADMIRAL OF THE FLEET

EARL JELLICOE OF SCAPA, O.M., G.C.B., G.C.V.O.

There are no brighter pages in our island story than those which deal with British ships and British sailors, and there is no more romantic theme than the life history of a great modern liner. This book, which is splendidly illustrated, is designed to give boys the life of a great liner, from the time it is planned in the draughtsman's office, right through its construction, showing the wonders of its building, its launching, commissioning, and finally the organisation that is necessary to run a floating city of 46,000 tons across the Atlantic regularly to scheduled dates, in the same way as express trains are run to fixed time tables.

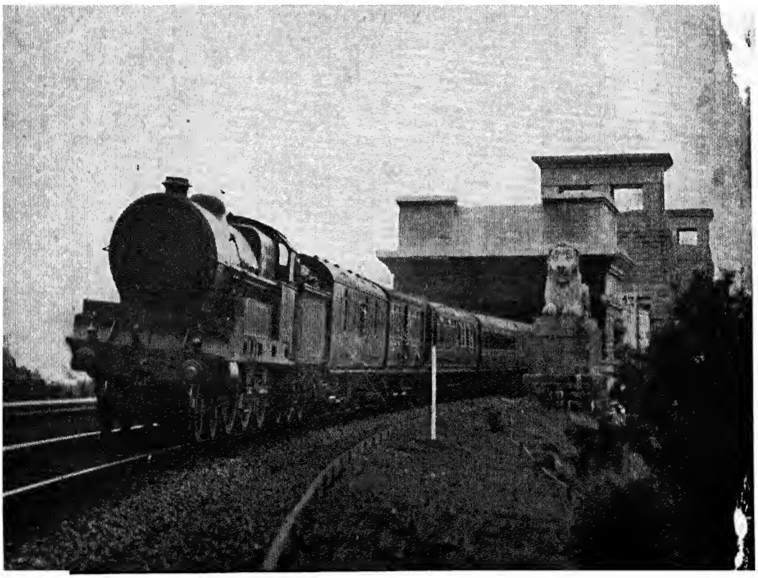
It is, in fact, the life story of the "AQUITANIA," known as "The World's Wonder Ship," and gains greatly in interest by being a first-hand description of a world-famous liner that is actually carrying thousands of passengers across the Atlantic every year. The whole romance of the ship is revealed; how it is steered and docked, what it means to supply 9,000 meals a day throughout the voyage, how wireless communication is maintained, and a thousand and one other details of absorbing interest.

BRITISH RAILWAYS

THE ROMANCE OF THEIR ACHIEVEMENT

G. GIBBARD JACKSON

This book attempts to tell of the evolution of our railways from the first struggles to the present day. It is a great story and one which it is difficult to tell adequately in a single volume. It is the romantic side of our railways that has been given particular attention here. The setbacks and victories, the mistakes, and failures to appreciate what lay before them, the constant efforts to more successful workings—all these are the things which matter.



THE IRISH MAIL LEAVING THE MENAI BRIDGE. *Photo L.M.S.*

An illustration from "British Railways."

BRITISH LOCOMOTIVES

G. GIBBARD JACKSON

"There are few boys who can resist the appeal of machinery in mass as represented by the railway engine. A wealth of information regarding 'iron monsters' from early nineteenth century days onwards, is contained in his fine book."—*THE SCOTSMAN.*

THE STORY OF THE BRITISH POST OFFICE

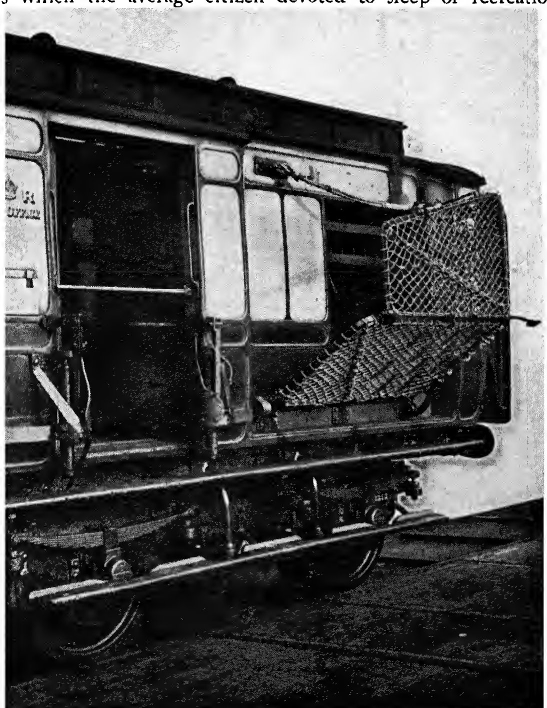
FROM POST BOY TO AIR MAIL

G. GIBBARD JACKSON

The story of the Post Office is not so well known as that of our railways, shipping, motors and aircraft. Possibly it is less exciting, yet it is one of great developments from very small beginnings.

Where our railways speak of thousands, the Post Office counts in millions—letters, postcards, bookpackets, parcels, telegrams and telephone call—are all counted in millions.

In this volume the author has tried to tell something of what goes on from day to day—and night to night, for the bulk of the work is done in the hours which the average citizen devoted to sleep or recreation.



END VIEW OF A POST OFFICE VAN SHOWING THE NET USED FOR CATCHING THE MAILS.

A reduced illustration from "From Post Boy to Air Mail."

PEEPSHOW OF THE PORT OF LONDON

A. G. LINNEY

Editor of the "P.L.A. Magazine."

The Rt. Hon. John Burns says:—

With good illustrations (nearly all from photographs he has himself taken, often in odd places), apt quotations, felicitous expression, and much technical knowledge, so good a book as this on a great subject deserves—as I feel sure it will get—a warm welcome from all.—*THE OBSERVER.*

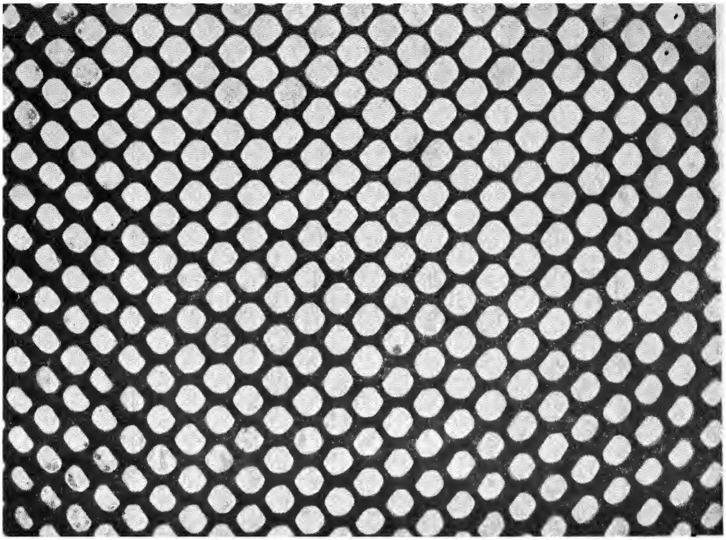
An Early Morning Scene off Tilbury.

An illustration from "Peepshow of the Port of London."

THE ROMANCE OF EXPLORATION

G. GIBBARD JACKSON

There can be few more romantic subjects in the world than exploration, and in this volume the author tells the story of the great explorers and the miracles of discovery that they have achieved. He relates the adventure of the old leaders, the intrepid sailors, like Vasco da Gama, Prince Henry the Navigator, and Columbus, and also of the men whose exploration is carried out in aeroplanes and motor boats.



Just a few of the Lenses in a Fly's Eye!
An illustration from "The Book of the Microscope."

THE BOOK OF THE MICROSCOPE

GERALD BEAVIS

Author of "The Romance of the Heavens."

To many people the microscope appears to be something which, whilst y interesting to the student, savours rather of work than play. Visions of ll professors taking in pieces of gnats and other small fry are conjured up and microscopy is labelled a dull pursuit. Is it? Ask anyone who has really taken the microscope to a plant or to a living thing, to a mineral or to the sand picked up on the sea-shore and they will tell you that they had missed half the wonders of the world until they used the magnifying glass.

It is the start which is the hardest part of this hobby of microscopy; once the beginning has been made, the rest can be left to the enthusiast, who will find an increasingly absorbing interest. In this book the author has tried to indicate where the beginner may find the greatest romance, how he may make, or obtain ready made his apparatus, how simple it may be, how inexpensive. The avenues for exploration are also indicated.

Special attention has been given to the more easily obtained specimens, and it will be apparent from the chapter headings what a vast field offers to the enthusiast, and particularly at the opening stages of his quest.

The microscope reveals many unsuspected wonders in the commonest things. Who for instance, would consider a spoonful of Epsom Salts the basis of some fascinating experiment?

The book, is in common with all others in the Romance Series, splendidly illustrated.

CLOSE-UPS FROM NATURE

F. MARTIN DUNCAN, F.R.M.S., F.R.P.S., F.Z.S.

Author of "Our Insect Friends and Foes," etc.

Mr. Martin Duncan, F.Z.S., the well-known naturalist, gives many remarkably intimate pictures of animal, marine and insect life. We are introduced to a fascinatingly interesting world by a master who is able to show us all the wonder and romance which is to be found even in the humblest of its denizens. The book, which is in complete harmony with the very latest research, gives, in popular form, the life histories of a very wide selection of subjects, concentrating on the life histories of many of the most interesting but least known creatures.

THE THRUSH'S NEST.
An illustration from "Close-ups from Nature.

THE ROMANCE OF THE CIVIL SERVICE

SAMUEL McKECHNIE

Editor of "The Civil Service Arts Magazine"

With a Foreword by THE RT. HON. PHILIP SNOWDEN, M.P.

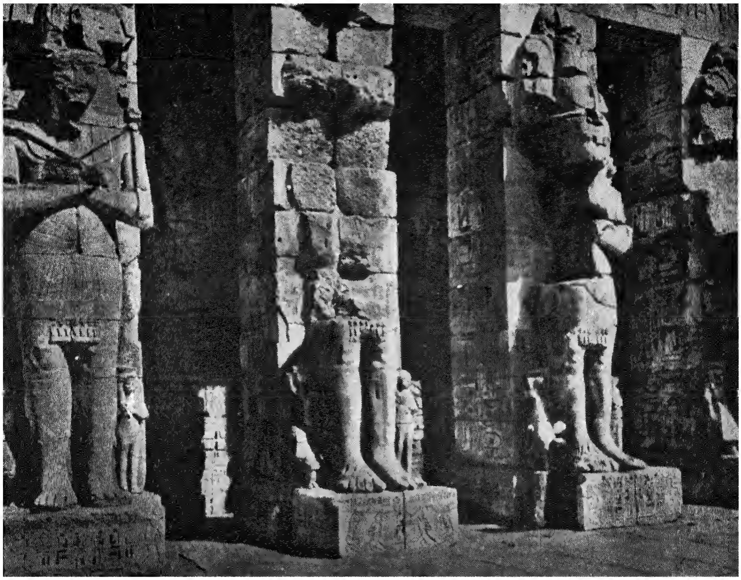
To talk about the romance of the Civil Service may seem paradoxical. The public knows very little that is accurate about the work which is done, and Civil Servants themselves very often see only the routine aspect of their own duties and know no more than anyone else what goes on in other departments. There are over eighty departments and more than four hundred thousand civil servants. The work therefore covers a very wide field. Whitehall itself is full of romance.

THE ROMANCE OF ARCHÆOLOGY

W. H. BOULTON

Author of "Babylon, Assyria and Israel," etc.

During the past hundred years a New World has been discovered, or rather, an Old World has been resurrected from the dust of ages. From the alluvial lands of Mesopotamia, from Egypt, from Greece and the Isles of the Mediterranean, men have been digging up the remains of the past, its palaces and its written records. The whole romance is told here including the tale of the discovery of the tomb of Tut-ankh-amen.



THEBES—THE TEMPLE OF RAMISES III.

An illustration from "The Romance of Archæology."

THE ROMANCE OF THE HEAVENS

GERALD BEAVIS

Author of "The Romance of the Microscope."

Everything has its romantic side, and though to many the Heavens seem too remote to share in the romance so frequently associated with distant countries and seas, they have proved a lure for others besides the astronomers.

In this volume an attempt has been made to deal with the romantic side, to explain some of the mysteries and to foster an interest in the celestial bodies.

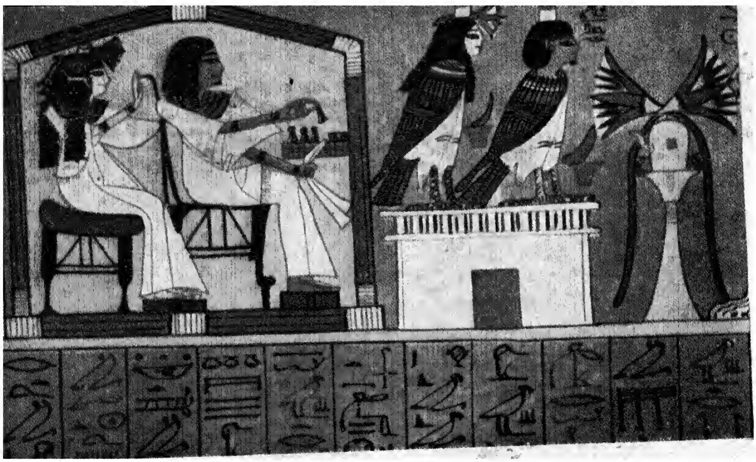
THE ROMANCE OF THE ANCIENT WORLD

TOM BEVAN

Author of "The British Empire Overseas"

Here, we read of the Golden Age of Greece, when Athens was the centre of the world and of the Augustan Age in Rome when all the nations of the world were dominated by the Imperial Eagle. It is no mere empty phrase, "The Romance of the Ancient World" as Mr. Bevan shows in this delightful volume.

The illustrations, too, form an illuminating commentary to the text. This is a book to delight all who love Romance and the tales of heroes and heroic achievement and would follow the early struggles of man and read of the rise and fall of mighty Empires.



A Marvellous Work of Egyptian Craftsmanship
An illustration from "The Romance of the Ancient World."

THE ROMANCE OF THE BRITISH EMPIRE

H. COURT, B.Sc., & L. COURT, L.L.A.

With a Foreword by The Rt. Hon. L. S. AMERY, P.C., M.P.

In this book the authors have set out to tell people in an attractive manner more about the wonderful Empire. In this book the reader will not find dull statistics, but interesting details as to how the people live in our dominions and colonies, what their cities are like and so forth.

In the days of economics and political interest peace can only come through a closer understanding; it is well and clearly written, the illustrations are illuminating. In fact all who have Imperial Welfare at heart and are desirous of a closer understanding of our Great Empire should read this book.